# SCIENTIFIC AMERICAN SUPPLEMENT


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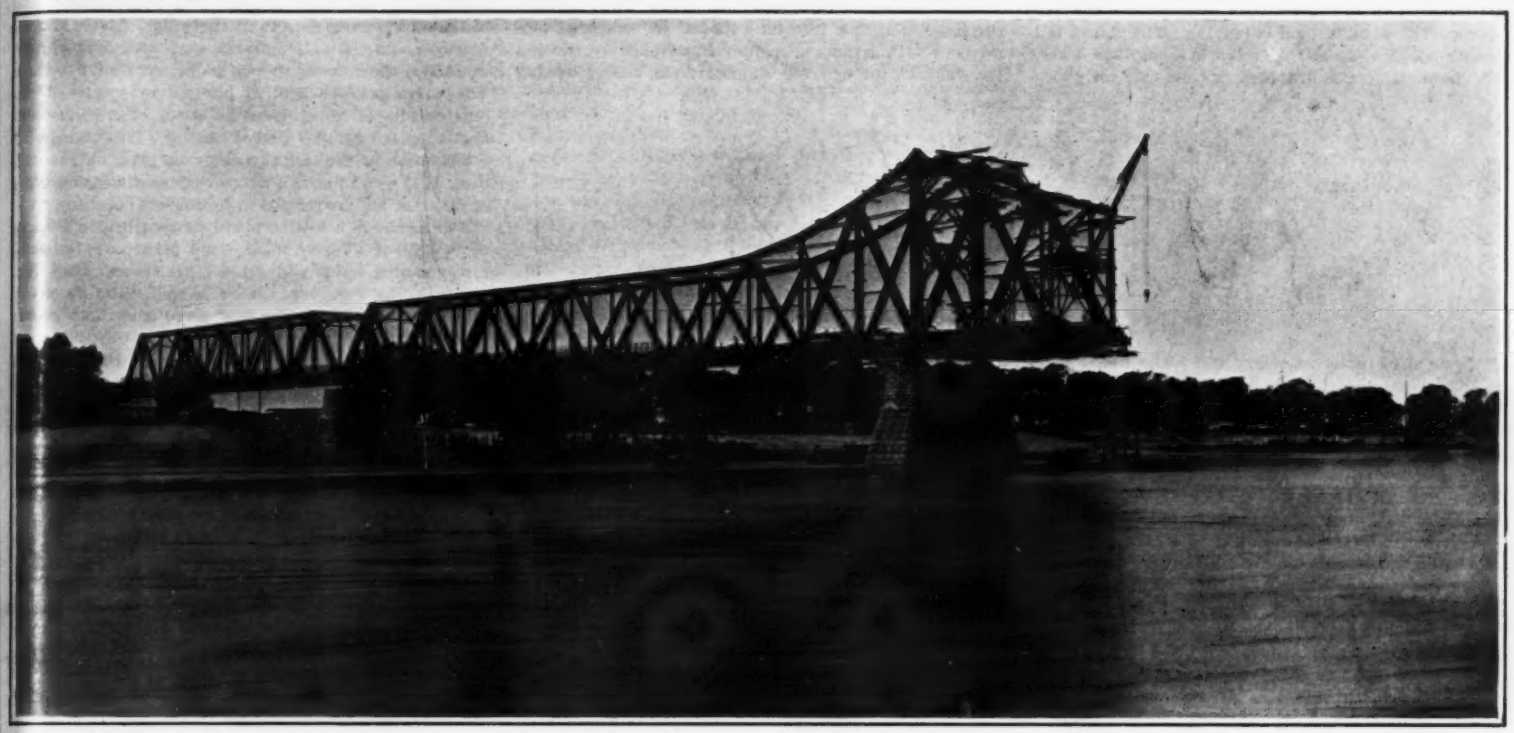
VOLUME LXXVIII] NUMBER 2028 NEW YORK, NOVEMBER 14, 1914 [10 CENTS A COPY $5.00 A YEAR



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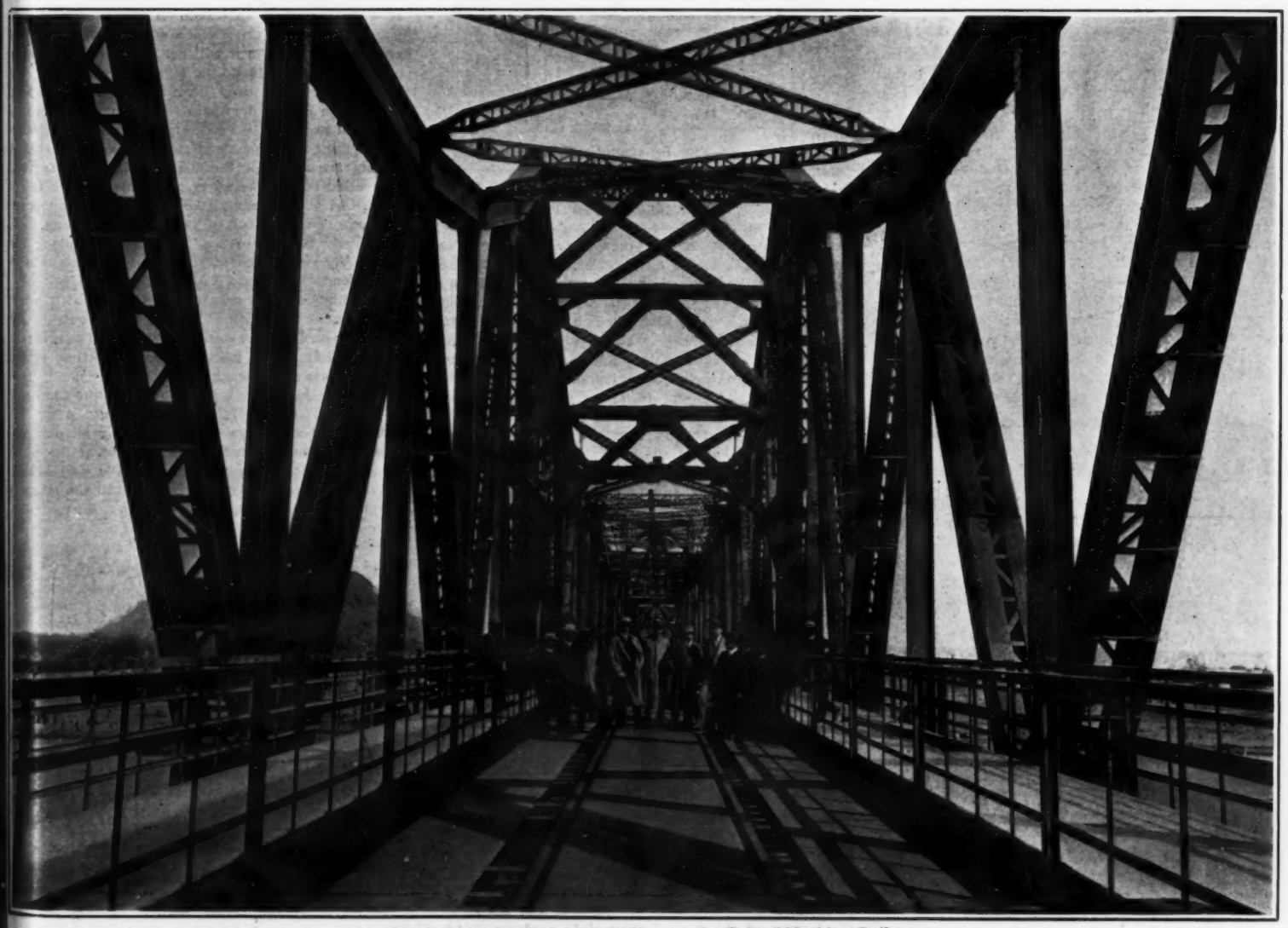


Looking through the Hoang Ho Bridge, on the Peking-Nanking Railway.

HOANG HO BRIDGE. A CONNECTING LINK BETWEEN THE CHINESE AND TRANS-SIBERIAN RAILWAYS.—[See page 308.]

# How to Collect and Preserve Insects—II*

## Methods and Apparatus Used in an Interesting Pastime

By Frank E. Lutz

Concluded from SCIENTIFIC AMERICAN SUPPLEMENT No. 2027, Page 291, November 7, 1914

MOUNTING.

We come now to the methods of mounting and preserving. The stock method is pinning. The almost universally adopted pin is 1½ inches long and has a very small head. It varies in thickness from extremely slender to as thick as an ordinary pin. The useful sizes are from No. 0 to No. 3. They are either plain "white" or enameled black. Much is to be said for both, with the voting probably in favor of black. At any rate, they should snap back when bent a reasonable amount. A pin that bends easily and stays bent produces profanity. Beetles are usually pinned through the right wing cover. All other insects, when pinned, are pinned through the thorax. In the case of flies it is well to pin a trifle to the right of the middle line, as the bristles on the back are important in taxonomy, and one side of the body at least should be perfect. True bugs should be pinned through the triangular portion of the thorax which is between the wings. See Fig. 7.

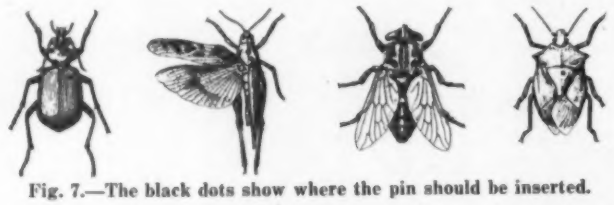


Fig. 7.—The black dots show where the pin should be inserted.

Very small insects are usually mounted on the tip of paper triangles, a medium sized insect pin being stuck through the broad end of the triangle. The triangles are of about as many sizes as there are collectors. A ticket punch can be purchased which has a die suitable for cutting these triangles. However, if they be cut with scissors or a sharp knife, such as a razor, a variety of sizes and shapes suited to different insects can easily be made. The best way is to cut tough, rather stiff paper into strips about three eighths of an inch wide and then snip off triangles from them by making transverse cuts. It is well to pin up a quantity of these triangles in odd moments and keep them on hand. When ready to mount, put a small bit of white shellac dissolved in alcohol or of some good elastic glue on the tip of a triangle and touch it to the underside of the thorax. Some difficulty will be experienced in keeping the insect straight on the point, especially if the adhesive be too thin. The triangles for ants should be fairly broad at the "point," and the front end of the abdomen, as well as the thorax, should be supported.

The method just mentioned is almost universally used for small beetles. Small flies and the like are frequently mounted on "minuten nadeln." These are short, very delicate, headless pins. Their use is illustrated in Fig. 8. Bits of pith, cork, or firm blotting paper (used edgewise) serve to connect the two pins. In the illustration the "nadel" is shown stuck through the insect and then into the support. A somewhat better plan is to arrange a number in advance by sticking the "nadel" through the support from below, leaving the point stick up, then mounting can be rapidly done by piercing the insects from below. It is well, in this case, to stop before the point comes entirely through the back, as then no pin shows, and furthermore, the characters on the back are not marred. "Minuten nadeln" have the advantage over glue on triangles that the glue does not always hold. On the other hand, the "nadel" cannot be used with many hard shelled beetles. Elbow pins (Fig. 8) are sometimes used, but are not very satisfactory as a rule. All mounts mentioned in this paragraph are usually put on the left side of the pin.

*Guide Leaflet No. 39, published by the American Museum of Natural History.

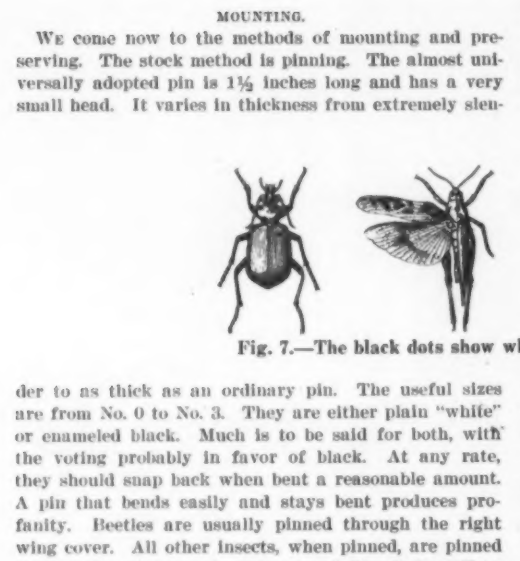


Fig. 9.—A common type of setting board showing different stages in "spreading."

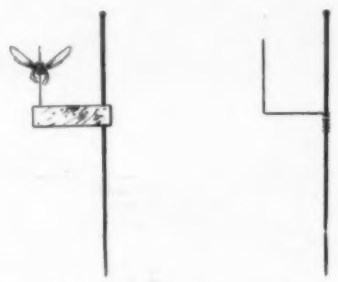


Fig. 8.—Pins for mounting small soft-bodied insects.

The height of the insects on the pin is important for the final appearance of the collection. A strip of cardboard whose width is one quarter to one third the length of the pin makes a convenient gage. With one edge held at the head of the pin, push the insect up until it touches the other edge. Or a block of wood containing a hole whose diameter is a trifle larger than that of the pin's head and whose depth is one quarter to one third the length of the pin may be used. Devices for regulating the height by sticking the point of the pin into a gage are not satisfactory because of the varying thickness of the specimens.

Mounting insects in balsam on glass slides will probably not be taken up by the general collector unless he be already accustomed to making balsam mounts. It is, however, the only satisfactory method of getting extremely small forms ready for study.

In collections, butterflies and moths usually have all four wings expanded to their utmost and more or less in line with the lateral axis of the creature's body. This makes a nice looking collection and is the best that can be done with most butterflies at least. However, many moths have natural rest positions which are not only interesting but economical of space. It is well therefore to expand the wings of the left side so that the markings on both front and hind wings show, but to leave the right wings in the natural rest position. The reason for expanding the left side rather than the right and for putting the triangles, etc. (see above) on the left side is that most people are right-handed. This arrangement makes it easy to use the pinning forceps with the right hand. Pinning forceps are strong forceps with broad roughened ends, and are useful in pushing the pins into the cork of the storage boxes. For the same reason when the wings of grasshoppers, wasps, etc., are spread it should always be the left wing.

The most common form of spreading board is illustrated in Fig. 9. The sides are made of soft wood. In the bottom of the central channel is a piece of soft cork. After pinning the insect, push the pin into this central cork until the back of the insect is nearly flush with the board. Then draw the wings to the desired positions by means of forceps or a fine needle caught in the strong front margin of the wings. Never use the fingers on moths and butterflies, as they will rub off the scales which cover the wings and give color to them. The wings may be held in position by means of fine pins or bits of heavy glass or strips of tracing cloth, held in place by pins placed outside of the wings. A combination of the last two methods, glass on paper, is best. It is well to have a number of boards with grooves of different widths for use with different sized insects.

Fig. 10 shows a setting board devised by Mr. Charles E. Sleight of Ramsey, N. J.—and perhaps by others—for spreading caddice flies and other insects when it is desired to have the legs spread as well. The holes running down the center are just large enough to accommodate that part of the pin which is above the insect. The wings are spread as before, except that now the under side is visible to the worker and the legs are accessible.

Flies (insects which have but one pair of wings), beetles (insects which have hard front wings), and bugs (insects which have the front part of the front wings leathery), are rarely spread, although they may be. The wings on at least one side of wasps should not be spread, as the way they fold them is of taxonomic value.

Should insects get dry and stiff before they are spread they must be relaxed. This is done by putting them in a covered jar or tin box containing water or moist blotting paper. A few drops of carbolic acid added to the water will prevent mould. Twenty-four hours will usually be sufficient to relax even the driest, but more time may sometimes be necessary. If the insect has neither scales nor hairs it can be quickly relaxed by immersing it in warm water.

It will be noticed that both of the setting boards illustrated here give the wings a slight upward tilt. If they keep this position it will not be objectionable, but they are not likely to do so, since the weight of the wings will probably drop them to the horizontal at least. Large insects dry more slowly than small ones, and it will probably be necessary to allow them to remain on the boards for about two weeks. They should certainly remain until thoroughly dried. No further preservation is then necessary, as a rule, for the fairly hard bodied adult insects. Some tropical grasshoppers have large abdomens full of fat and decomposing food. They should first be opened by an incision along the belly, the viscera taken out, and the abdomen stuffed with cotton.

Caterpillars may be prepared in the following way: Make a circular incision at the hind end, cutting the intestine loose from the outer body wall. Then, laying the caterpillar on a piece of clean blotting paper, squeeze the viscera through this opening by gently rolling it with a lead pencil, beginning near the hind end and gradually working toward the front. After the viscera have been gotten rid of, for the most part, insert a straw and fasten the first segment of the larva to the end of the straw by means of a fine needle. Draw the hind segment up the straw until the larva is

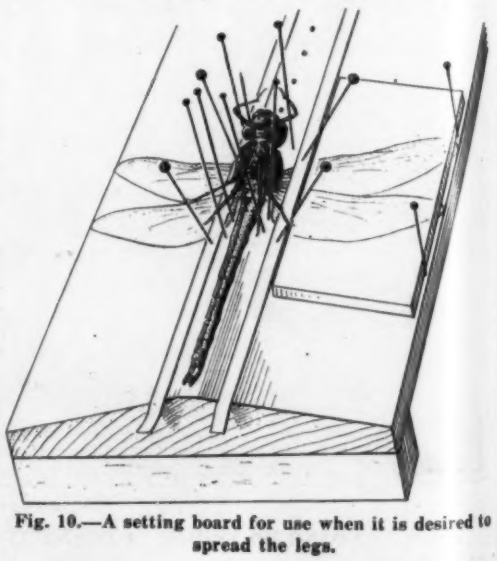


Fig. 10.—A setting board for use when it is desired to spread the legs.

natural length and fasten it in the same manner. Then inflate the larva by gently blowing through the straw. Since the front end of the straw may get plugged up, it is well to make a small hole in the side of the straw before it is inserted. This hole had best come about midway between the larva's head and tail. Since inflation must be kept up until the larva's skin is dried, gentle heat is usually used. A tin can with holes punched in it for ventilation and heated by an alcohol lamp makes a good oven, or one made for the purpose can be purchased. Dealers also sell bellows, tubing, clips, etc., to make the work of inflating easier. At a recent meeting of the New York Entomological Society, Mr. Thomas Hallinan of Erie, Pa., exhibited caterpillars which had been filled with dry sand poured in through a funnel after evisceration. After drying, the sand can be poured out. However inflated, green larvæ are apt to lose their color, for it is chlorophyll, which fades rapidly. Slow drying paints relax the skin and distort it. Therefore, if painting is done, the pigments should be mixed with benzine or the like.

FIELD NOTES AND LABELS.

It is only by the greatest chance that the beginner gets a new or even rare species on ground that has been worked over by experienced collectors, but even the primary class in entomology may add to our store of knowledge if it keeps field notes well. Date of capture and locality are considered of prime importance. They should always be known and kept with every specimen, but the distribution and time of appearance of our more common species are known. It is of their habits that we are ignorant. What do they feed on? Under what conditions are they to be found when young and when old, day and night, winter and summer? What do they do, and how do they do it?

A sample field card is shown in Fig. 11. The "Remarks" are really the important part. In using this card the lower right hand number is torn off (after filling out the card *in the field*) and kept with the specimens to which the card refers until they are individually labeled. This is the card used in the American Museum. The stub is kept by the collector and the card is filed at the museum. Such a refinement of system is not necessary in most cases, but some system is imperative if your collection is to be worth while.

The pin label should be small but legible. Certain firms make a business of printing these labels from small type, or the collector can make up a sheet by means of an ordinary typewriter (black ink is best) and have a block made from this greatly reduced in size. From this block any number of impressions can be made. Any printer will attend to the whole business. Dates should be filled in before cutting the labels apart. Field numbers can be written on the back of these labels or put on a separate label. The collector's name can also be put on a separate label. Similar labels should all be the same height on the pin throughout the collection.

STORAGE BOXES AND CARE OF COLLECTION.

Since certain members of a family of beetles (Dermestidæ) are given to eating dried insects, the storage boxes should have tight-fitting lids. Except for that, almost anything will do. Cigar boxes are not bad if carefully watched, but better boxes can be purchased at reasonable prices from dealers. Glass topped drawers are nice but not necessary. Whatever sort of box is used, the bottom, inside, should be covered with something which is soft enough to allow a pin to enter easily, but which will hold the pin when it is once in. The compressed cork of the dealers is best. Sliced cornstalk is used by some beginners, but two layers of the corrugated paper such as bottles are packed in is better than corn pith. The layers should be placed so that the corrugations run at right angles to each other.

In spite of precaution Dermestids may get in, although camphor balls or the flaked naphthalene will help to keep them out. If camphor balls are used, first heat the head of an ordinary pin, and while hot push the head into the ball. When cool, it will be solid, and the ball can be pinned into the box. If Dermestids do get in, they may be killed by pouring into the box about a teaspoonful of carbon bisulphide and closing the lid down tightly. Remember that the bisulphide is very inflammable.

PACKING INSECTS IN THE FIELD.

It frequently happens that the collector cannot attend to his catch at once, or possibly for months. Of course those things which are collected in alcohol may remain there. Butterflies and the like should be put into triangular envelopes. The manner of making these is shown in Fig. 12. Never put more than one specimen in an envelope. Other insects can be packed between layers of cotton and cheesecloth, with naphthalene flakes put in to keep out ants, etc., or they can be put in sawdust. In the latter case it is well to sprinkle carbolic acid on the sawdust to prevent mould. An excellent method of packing insects (except butterflies and moths) which are to be dried, is to make tubes of unglazed paper around a lead pencil, first writing the data on that part of the paper which comes outside. One end is closed by folding in the paper there, and then the tube is nearly filled with freshly killed insects. Finally the other end is closed by folding in the paper. These tubes and the triangular envelopes can be packed in a cigar box, and if sprinkled with naphthalene to keep out ants and Dermestids will keep indefinitely. Never pack moist insects in a tin box and never close even a wooden box tightly if there are any moist insects in it. Mould will result if you do.

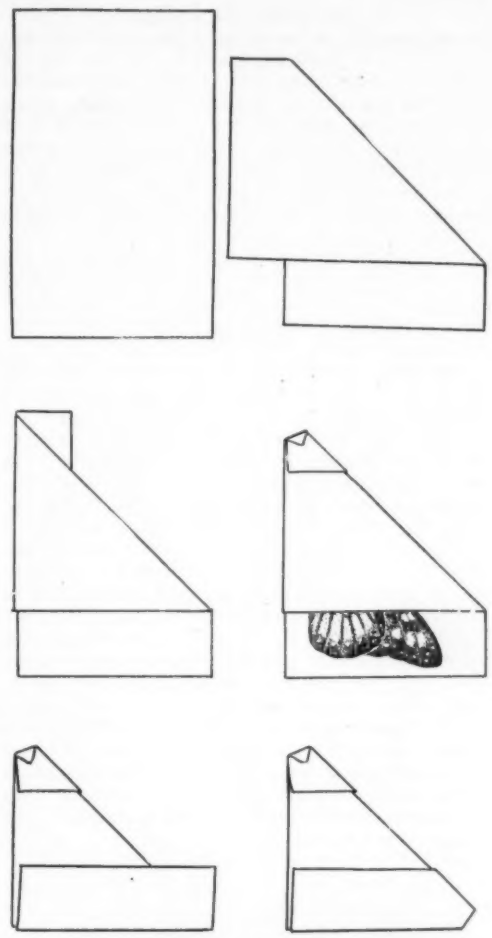


Fig. 12.—Method of packing a butterfly. The paper used in making the envelope should be stiff enough to protect the wings.

FINALLY.

Do not forget that information about the insects is usually of as much value as the specimen—or more.

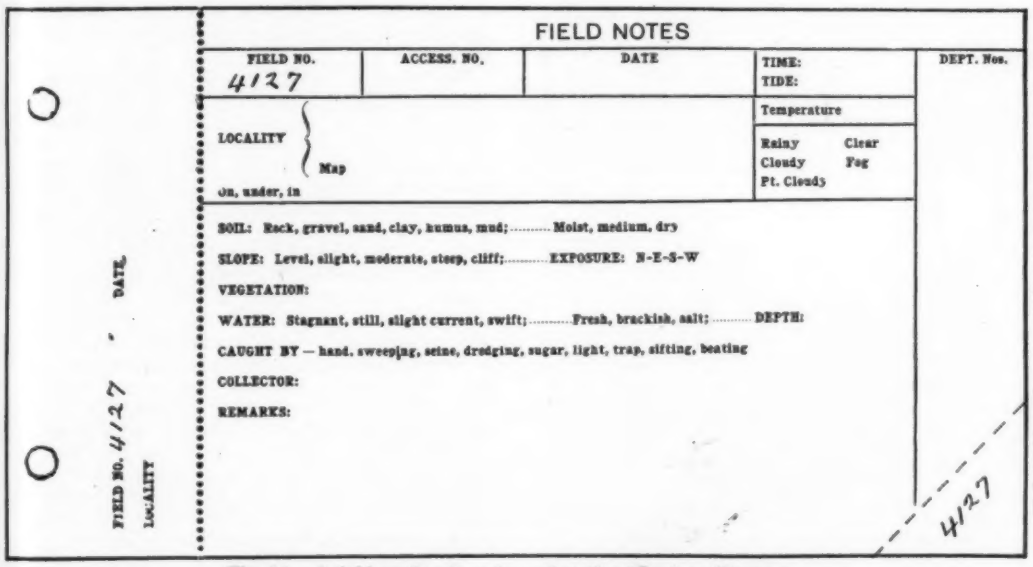



Fig. 11.—A field card such as is used at the American Museum.

## A Course of Science Reading

**By James Asher**

In choosing books the users commonly select them without much regard to the suitability of the books for their needs and without much regard to their sequence in order of difficulty.

Because of lack of properly arranged courses of reading, much valuable time is not utilized in the best possible manner.

Having been deeply impressed by the lack of system pursued by many persons who are desirous of becoming well informed in science, the writer has carefully selected a list of books for readers of a general course in practically all the sciences.

The list of books below on the natural, physical, and mathematical sciences, is for the use of those who have at least a public school education or its equivalent.

The first place is given to the natural sciences, the second to the physical, and the third to the mathematical sciences. In the list of natural sciences the first place is given to hygiene, because it treats of the life and health of man. In the list of physical sciences the first place is given to physics, which was formerly called natural philosophy. According to Francis Bacon, this is the great mother of all the sciences. The first place in the list of mathematical sciences is given to arithmetic, which is always the first to be studied in a mathematical course, and which is by far the most useful of the mathematical sciences.

For one who cannot afford a college education, the steady pursuit of the course here given should be a good substitute. It may, with advantage, extend throughout four years, which is usually the time required in securing a college education.

A man, after having successfully pursued this course for four years, would almost certainly be imbued with the scientific spirit; that is to say, the spirit of care and accuracy. He would almost certainly have increased mental power, a broad culture, and a fund of knowledge and power which should be of benefit to him in any walk of life.

The list is as follows:

"A Manual of Personal Hygiene." W. L. Pyle.
"Lessons in Elementary Physiology." T. H. Huxley.
"American Natural History." W. T. Hornaday.
"The Elements of Botany." A. Gray.
"New Physical Geography." R. S. Tarr.
"First Book in Geology." N. S. Shaler.
"Textbook of Mineralogy." E. S. Dana.
"Elements of Physics." A. P. Gage.
"Inorganic Chemistry." I. Remsen.
"Astronomy for Everybody." S. Newcomb.
"Descriptive Meteorology." W. L. Moore.
"Advanced Arithmetic." G. A. Wentworth.
"Mensuration for Beginners." I. Todhunter.
"Complete Algebra." G. A. Wentworth.
"Plane and Solid Geometry." G. A. Wentworth.
"Plane and Spherical Trigonometry, with their Application to Mensuration, Surveying, and Navigation." E. Loomis.

## The Principle of Similitude

In an article in *Physics*, Rev. R. C. Tolman brings forward some arguments that seem to hold good throughout the field of physical science.

The fundamental entities out of which the universe is constructed are of such a nature that from them a minute universe could be constructed, exactly similar to the present universe. This is called the principle of similitude. This fundamental postulate is a relative principle; that is, the principle of relative size. In Mr. Tolman's paper it is shown that relations must hold between the changes of lengths, masses, time intervals, energy quantities, etc., in order to construct the miniature world in question.

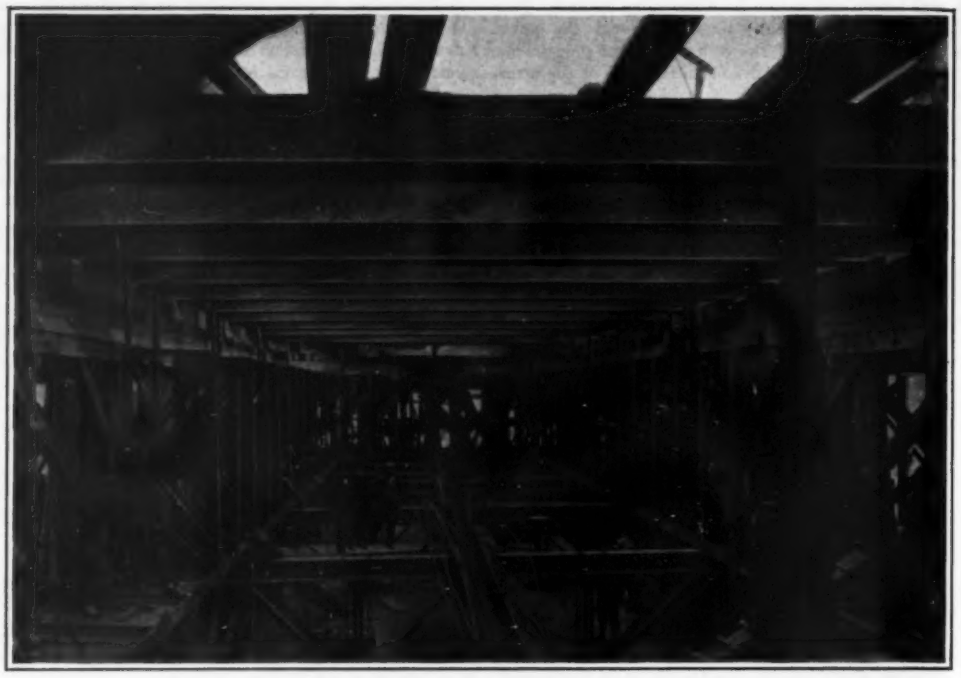
## The Hoang Ho Bridge

### An Important Link in Railroad Communication in the Far East

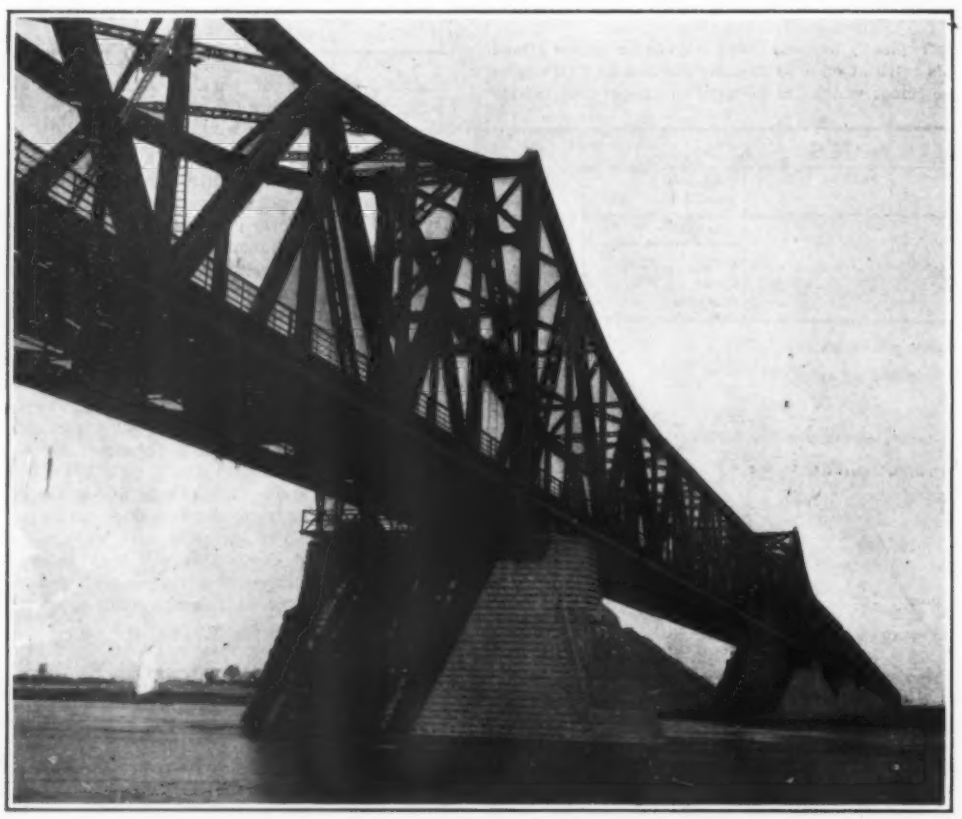
AN interesting bridge has recently been completed across the Hoang Ho, or Yellow River, in China, by the Maschinenfabrik Augsburg Nurnberg Ag, which is of special importance because it forms the connecting link between Peking and Nanking, and establishes direct communication between these two cities and the Trans-Siberian Railway, thus making it a notable feature in the advancement of rail communication of the world. Great care was required both in the designing and the erection of this bridge on account of the uncertain nature of the Yellow River, which is frequently subject to flood conditions, and the water rises several meters within a few hours.

This bridge, which is the largest stone pier bridge in China, is about 4,120 feet in total length, and the portion over the main bed of the river is on the cantilever principle, with a central span of about 540 feet, on either side of which is an anchor span of about 421 feet. There are also nine truss spans, each of about 304 feet, eight at one side of the river and one at the other, which carry the line over the bottom land that is flooded at low water. The spans rest on piers of reinforced concrete and stone, but as no solid rock foundations could be found, the piers were built on reinforced concrete piles which were driven at an angle to give a spreading base. For the central river pier a compressed air caisson had to be used on account of the great depth of the soft and unreliable material of the river bed.

At present only one line of track has been laid across the new bridge, with a footway on either side; but this is only considered a temporary arrangement, for it will be a simple matter, when increasing traffic demands it, to remove the footways to outside brackets and to lay a second track, and this is the final arrangement contemplated in the original plans.



Inside the caisson of the central pier.



Main channel pier and cantilever span.

The accompanying illustrations give a good idea of the character and details of the bridge, and it will be seen that it is a very substantial and symmetrical structure that can be seen rising from the plain a long time before it is reached. Its cost was 4,564,358 kooping taels, or roughly, about $2,800,000.

## Leadless Glazes on White-Ware

THE possibility of devising a glaze for white-ware that does not contain lead in any form has been studied by the U. S. Bureau of Standards, and the experiments and conclusions of E. T. Montgomery, assistant ceramic chemist, are told in one of the recently issued Technological Papers issued by the Department of Commerce, from which the following facts are derived:

The glazes used on white-ware are composed of borosilicates of the alkalies, lime, lead, and alumina, which are applied to a body previously fired to the desired maturing point approaching vitrification more or less closely. The same type of glaze is also employed with American porcelain and the English bone china as distinguished from the Austrian, French, and German products where, because of the low biscuit and high glost firing temperature, it is possible to use leadless glazes.

The use of lead oxide, commonly introduced as the carbonate, has given rise to a wide-spread agitation concerning the poisonous nature of the compound and its deleterious influence upon the health of the workmen under conditions permitting careless operation and neglect of ordinary sanitary precautions. A study of American white-ware potteries shows, however, that such conditions as have been described as existing in European works do not prevail and that in reality the ill effects due to plumbism are very slight in extent. It cannot be denied that there is a potential danger, but the enforcement of rules concerning ordinary cleanliness and ventilation suffices to prevent lead poisoning.

An extensive series of experiments were made with a number of glazes that contained no lead, accompanying a thorough investigation of all phases of the subject, with the result, in the opinion of the investigator, that it would be very premature at the present time to say that we can make a leadless glaze for white-ware, china, or porcelain that could be substituted for the present lead glazes. Both have special faults and special virtues, but for use under general factory conditions, make them as perfect as we can, we are not likely to find any element, compound, or combination of compounds which will exactly duplicate the many excellent properties of lead as a glaze ingredient.

## Direct Determination of Rubber by Combustion Method

A METHOD that can be employed quite satisfactorily has been developed by L. G. Wesson, of the U. S. Bureau of Standards. It is described in No. 35 of the Technological Papers published by the Department of Commerce as follows:

The procedure, in brief, consists first in forming the nitrosite of rubber by the action of nitrogen trioxide gas upon a finely ground and acetone-extracted sample of the rubber suspended in chloroform. The insoluble nitrosite, fillers, etc., are then filtered out and the nitrosite dissolved in acetone. The suspension of finely divided mineral matter is then allowed to settle out, or is thrown down with the centrifuge. An aliquot portion of the solution is transferred with a pipette to a small flask, and its volume reduced by evaporation to a few cubic centimeters. This small volume of acetone solution of the nitrosite is now transferred with the help of ethyl acetate to a porcelain boat containing alundum, and, after the acetone and ethyl acetate have been expelled by warming the boat for several hours in a drying oven, the nitrosite is burned in a current of oxygen and the carbon dioxide thus formed is absorbed in soda-lime and weighed. If all of the carbon originally in the sample as rubber, and only such carbon, reaches the soda-lime apparatus as carbon dioxide through the intermediate nitrosite, the equation $C_{10}H_{16} = 10CO_2$ enables one to calculate the $C_{10}H_{16}$ or real caoutchouc content of the sample.

The results indicate a fair degree of reliability for both raw rubber and high-grade vulcanized compounds. The use of this method for the analysis of low-grade compounds and for the simultaneous determination of sulphur of vulcanization may be possible with further study.

## Difference of Longitude Determined Photographically

BY a method described by G. Lippmann in *Comptes Rendus* it is possible to obtain a photographic record of the difference of longitude between two stations without any transit instrument or personal observation error. A telescope is arranged to photograph a small region of the zenith at each station. Into each of these a collimator is adjusted so as to project the image of a small illuminated slit on the plate showing the star images, the beam of light from the collimator being adjusted to exact verticality by a mercury surface. By these means the artificial images are impressed simultaneously on the star plates at the two stations by employing electric sparks operated by a mechanical device to discharge exactly in unison with the receipt of a wireless signal from some central station such as the Eiffel Tower. The difference in right ascension of the two artificial marks on the photographs is then obtained from a knowledge of the star positions from standard catalogues. By taking a series of exposures on each plate the accuracy of the result can be appreciably increased.

# A New Apparatus for the Direct Measurement of Radioactivity*

## Of Value in Both Chemical and Electrical Investigations

MEASUREMENTS of radioactivity constitute an exceedingly sensitive method of chemical analysis by which it is possible to measure quantities of radioactive substances too small to be detected by the spectroscope. This result is due partly to the extraordinary properties

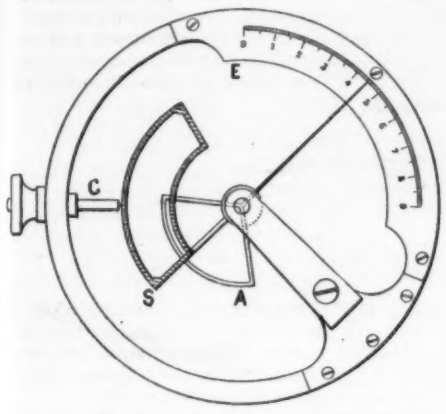



**Fig. 1.—Plan of Szilard apparatus for direct measurement of radioactivity.**

of the radioactive elements, and partly to the sensitiveness of certain electrical instruments, which were in use before the discovery of radioactivity, and which have greatly facilitated its study. The most important of these instruments are the gold leaf electroscope and the quadrant electrometer. The sensitiveness of the former resides chiefly in the lightness of the moving parts, that

**Fig. 3.—View of complete apparatus.**

of the latter in the ingenuity and delicacy of its construction. These sensitive but fragile instruments are suitable only for the use of expert physicists who are able to convert their readings into absolute measurements by means of rather complex methods of comparison and calculation. The deflections of the gold leaf electroscope are read with the aid of a microscope having a micrometer eyepiece; those of the quadrant electrometer are indicated by a spot of light moving on a transparent scale.

My object was to construct an apparatus which would measure radioactivity as directly as the amperemeter measures current strength, and by the same means (a graduated scale and a rigid needle). This problem appears difficult when we remember that the forces called into play in radioactive measurements are a thousand million times smaller than those which are employed in a milli-amperemeter, and that these forces are derived, not from a material substance, but from an independent electric charge which is communicated to the apparatus and which is liberated by the conductivity conferred upon the air by radioactive agents.

For these reasons I constructed an apparatus in which the weight of the moving parts is reduced to the minimum, and the rotary displacement caused by minute electrical variations is as great as possible.

The construction of the apparatus is indicated in Figs. 1 and 2. The needle *A* is formed of a narrow ribbon of sheet metal and comprises two rigidly connected parts: a long pointer and a hollow circular sector. It is attached to a very short axis *X*, which turns on ruby bearings. This axis is attached to the lower end of a helical spring *R*, the upper end of which is fastened to the bridge *P'*. The spring serves both to suspend the needle and to oppose its rotation.

An insulated rod *C*, sliding through the wall of the case, allows an electric charge to be communicated to the fixed double sector *S*, into which the sector of the needle *A* is drawn to an extent proportional to the charge, causing the pointer to move over the scale *E*.

In order to attain the desired result it was necessary to impose upon the dimensions and weight of the parts limits that taxed the skill and patience of expert watchmakers. The needle is about 2 inches long, 1/1,250 inch thick, and weighs 1/7 grain. It was cut from one sheet of tempered steel. The axis, of the same material, weighs 1/65 grain. The suspending spring is made of a ribbon of steel 1/2,500 inch thick.

The fixed sector *S*, the only part that carries an electric charge, is insulated by the amber plate *I*, through which the support of the sector extends into the lower chamber, which contains the radioactive substance. The needle is always connected to earth through the sus-

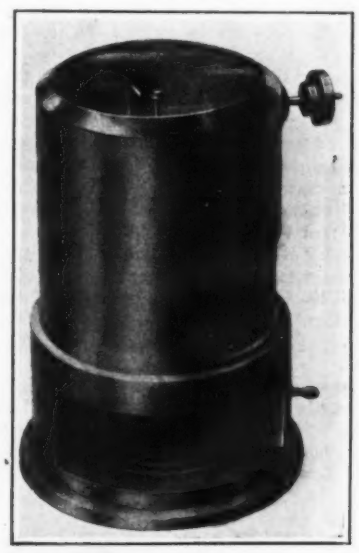


**Fig. 5.—Apparatus combined with a special condenser for the measurement of large quantities of radioactive substances.**

pending spring, so that it is never charged. This is a very important detail. It allows the scale to be placed very near the needle and gives certainty to the operation of the instrument. A charged needle would adhere to the scale and make measurement impossible.

In the use of the apparatus a small charge is first communicated to the fixed sector *S* by means of the insulated rod *C*, which is pushed inward until it almost touches the sector. The charge attracts the sector of the needle *A*, causing the needle to turn on its axis. A charge obtained by rubbing a piece of sealing wax or an ebonite penholder is sufficient to produce the maximum deflection of 90 degrees. The needle remains in this position as long as the fixed sector retains its charge. The apparatus may be shaken and the needle may be touched with the hand without altering the deflection. A charged instrument was carried from Paris to Berlin without losing its charge.

When a radioactive substance is placed in the lower compartment the air is gradually ionized, the fixed sector *S* is gradually discharged, and the needle, impelled by the spring, returns at a uniform rate toward the zero mark. If the radioactive substance is removed the movement of the needle instantly ceases.

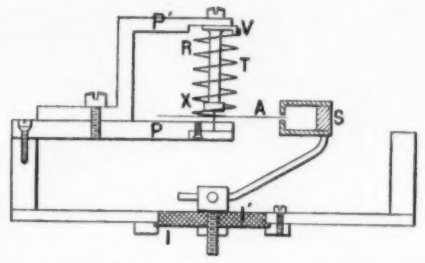



**Fig. 2.—Vertical section through the apparatus.**

The movement is very easily observed. For example, a small quantity of the feebly radioactive oxide of uranium causes the needle to move about one fourth as quickly as the pointer of a stop-watch. The apparatus possesses another great advantage in its fixed and correct scale, which allows direct measurements to be made. The scales of ordinary electroscopes and electrometers are movable and arbitrary, so that each measurement necessarily involves a comparison with a standard radioactive substance. In the new apparatus, the security of the mounting and the constancy of the opposing force of the spring make it possible to standardize the scale once for all.

**Fig. 4.—Szilard apparatus for direct measurement of radioactivity.**

I use a scale based on the radioactivity of the black oxide of uranium, $U_3O_8$. A surface of 25 square centimeters (about 4 square inches) covered with a layer

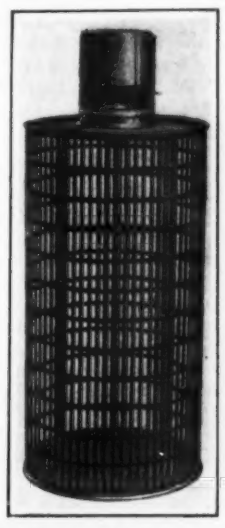


**Fig. 7.—Interior of the gas condenser.**

* Translated from B. Szilard's article *La Nature*.

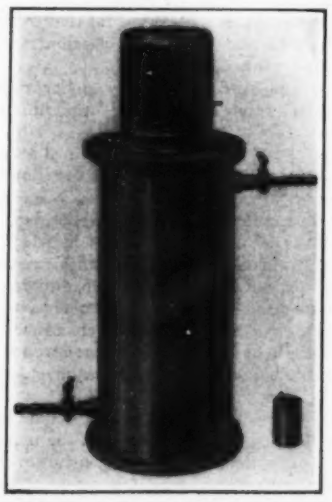


**Fig. 6.—The apparatus combined with gas condenser for measuring emanations from mineral waters.**

of this oxide of suitable thickness (increase in thickness beyond a certain limit produces little change in radioactivity) causes the needle to move over one scale division per second. The radioactivity of any other substances is measured by placing the substance in the apparatus and counting the number of seconds, as given by a seconds' clock, occupied by the needle in traversing a given number of scale divisions. The number of divisions divided by the number of seconds expresses the radioactivity of the substance directly in uranium units. An equivalent method consists in counting the number of scale divisions which the needle crosses in 100 seconds.

Boltwood has found that of the total radioactivity of uraniferous minerals about 20 per cent is due to uranium, 60 per cent to radium and its derivatives, 10 per cent to ionium, and the remainder to actinium and other elements. It is known, also that a mineral which exhibits (in a thick layer) a radioactivity of one uranium unit contains from 20 to 30 per cent of $U_3O_8$, and about one part of radium to each 3,000,000 parts of uranium. With the aid of these data a nearly complete analysis of the radioactive ingredients of a mineral can be made by one measurement, effected in less than one minute. Minerals containing thorium can be analyzed in the same way. The same method is applicable to all solid radioactive substances, natural or artificial, such as the mud and residues of hot springs, pharmaceutical products, etc.

For the direct determination of larger quantities of radium (0.1 to 100 milligrammes) the apparatus is attached to a special condenser (Fig. 5), which allows only the gamma rays to pass into the ionizing chamber. For this purpose the scale is so constructed that a displacement of one division per second corresponds to one milligramme of pure radium. The uranium scale may be employed, however, if the ratio between the two units has been determined for the apparatus.

For the measurement of radioactive emanations of mineral waters, and other substances, solid, liquid, or gaseous, the apparatus is combined with a gas condenser (Figs. 6 and 7). In this way it is possible to detect the radioactivity of one ten-millionth of a milligramme of radium, which is the average radium content of 100 grammes (about 3 ounces) of granite.

The apparatus may be employed as an electrometer in researches which have nothing to do with radioactivity. Its sensitiveness is indicated by the facts that its capacity is 2 electrostatic units and a current of $10^{-13}$ amperes causes the needle to move at the rate of ½ degree per second. Hence the apparatus is well adapted for the measurement of atmospheric potential, the electric charge of rain drops, and the ionization of the atmosphere.

# Radium Therapy

## Notes on Results Obtained at the London Radium Institute

THE report of the London Radium Institute for 1913 shows that a great variety of cases were treated, and, as the Institute makes it a rule not to treat cases of malignant diseases that are operable under ordinary circumstances, the greater part of its work is necessarily in the nature of a last resort. It is therefore a matter of great interest to note the unexpected number of such cases that are classed as apparently cured. Of course such a result can only be positively claimed after the lapse of a long period of time, probably several years, when it can be definitely shown that no new manifestations of the original disease have appeared; still, with the short period for observation that has yet been possible the indications in a very satisfactory percentage of the cases treated have been of an encouraging nature.

The following notes constitute a brief summary of the cases included in the report of the Institute, which is a valuable contribution to the literature of radium therapy.

The results obtained in the treatment of epitheliomata affecting glabrous surfaces call for no fresh comment, and in suitable instances removal of the growth by radium may be confidently anticipated.

Epitheliomata of the buccal, lingual and pharyngeal mucous membranes still prove both refractory and disappointing in their response to radium, but a new method of treatment has recently been devised which in instances of cancer of the tongue has given distinctly encouraging results.

Several cases of epithelioma of the œsophagus have been under treatment, but unfortunately the majority of these have been in so advanced a stage as to preclude all hope of success. In those instances however where complete occlusion had not occurred, and it was possible to introduce radium actually into the lumen of the growth, distinct though temporary benefit has resulted; and that this effect is not merely mechanical, due to the dilation of the stricture by the apparatus, is evidenced by the fact that the improvement in the power of swallowing has persisted for six or even nine months after the termination of the treatment.

Carcinoma of the uterus still continues to yield most gratifying results, and the effects of radium treatment in inoperable cases are far in advance of those obtained by any other known medical or surgical methods. The local manifestations of the disease are benefited in the most striking fashion, and the complete disappearance of fungating growth, arrest of hemorrhage and discharge, healing of ulcerations and relief from pain are phenomena of almost daily occurrence. In favorable cases, moreover, the treatment appears to exert a distinctly retarding influence on the dissemination of metastatic deposits, and thus to arrest the progress of the disease. It is not possible, however, to speak of "cure" even in these latter instances.

Great care must be exercised in the treatment of recurrences, which make their appearance within six months of the performance of a Wertheim's operation. The functions of the trophic nerves of the pelvis seem often to be seriously impaired by the extensive and elaborate dissection which is associated with this method of hysterectomy.

In cases of carcinoma of the breast many patients exhibit a great susceptibility to radium; the primary growth becomes smaller, infected glands and subcutaneous nodules lessen or perhaps even disappear. Little or no effect appears to be exerted in the prevention of metastatic deposits, though the treatment does not, at any rate, hasten their dissemination. Some cases in which pleurisy, dependent upon carcinomatous invasion of the pleura, had been present have shown remarkable improvement.

A few patients have been under treatment at intervals of three or four months since the opening of the Institute in September, 1911, and it has been noted that a stage in their treatment is reached sooner or later at which the response to radium fails, and the benefit derived becomes negligible.

Encouraging results have been obtained in the few instances of carcinoma of the thyroid that have come under notice, the progress of the disease has been arrested, and a decrease in the size of the existing growth has been obtained, the general discomfort and dysphagia when present being greatly relieved.

The superficial lesion in Paget's disease is usually speedily cured by one hour's exposure to a half strength plate unscreened, but the underlying induration and affection of glands, if present, require prolonged treatment with heavily screened applicators if any real benefit is to be obtained; in cases in which the patient is willing to submit to operation this procedure should always be adopted.

Carcinoma of the rectum displays much variation in its response to radium therapy, and numerous factors have to be considered in prognosis. Speaking generally, the soft annular and vascular type of growth is much more favorably affected than the flat, hard, non-annular plaque with much subjacent induration. In the treatment of this latter class of growth the action of the gamma rays (which it is impossible to prevent) on the healthy rectal mucous membrane opposite the plaque produces a proctitis, which though generally transient, sometimes proves both persistent and severe, and adds greatly to the patient's discomfort. In the treatment of the former type, if the radium tube be of proper dimensions and introduced accurately within the lumen of the growth, little or no healthy mucous membrane is affected by the gamma rays, and no proctitis occurs.

Growths situated in the upper half of the rectum appear to be more amenable to treatment than those in the lower, though this may be due to the fact that tenesmus is always more constant and severe when the growth is near the sphincters.

The number of cases of carcinoma of the prostate which have been treated up to the present is not very large, but benefit has been noted in all of them. Haematuria, when existent, has been either diminished or abolished, pain has been greatly lessened, and the size of the growth decreased.

Nine cases of carcinoma of the bladder have been treated, and in six instances the results have been most gratifying. The haematuria, cystitis, and all subjective symptoms have disappeared, and cystoscopic examination has shown that the size of the growth has been greatly lessened, and any ulcerated surface has become covered with healthy epithelium.

But little has been added to our knowledge of the treatment of rodent ulcer, but when dealing with the question of prognosis it appears justifiable to divide rodent ulcers into two definite clinical types:

1. The hypertrophic nodular type, with slight superficial ulceration of a scaly character. This class responds extremely well to radium, and yields most satisfactory results.

2. The excavating type, with undermined and overhanging edges and a gelatinous base. This not infrequently proves very intractable, and repair is most difficult to effect.

Rodent ulcers attacking cartilage, bone or mucous membranes are very refractory, though an exception should be made with regard to the orbital mucosa, which is generally very amenable to the action of radium.

Speaking in general terms sarcomata, if taken in their early stages, and before dissemination has occurred, do very well under radium treatment.

The best results are obtained in sarcomata of the tonsil and postnasal space, and the results in many such cases are amazing, the growths completely disappearing within six weeks of the treatment. Lymphosarcomata also give excellent results. Melanotic sarcomata are not influenced by radium, and in the few cases that have been treated no benefit has been observed.

In lymphadenoma when the disease is localized and confined to one or more small superficial areas the disappearance of the enlarged glands is frequently brought about by the use of radium, and the progress of the disease is thus arrested.

When, however, the condition is generalized, the employment of numerous large and powerful applicators becomes necessary, and this heavy dosage is almost always followed by severe systemic disturbance, with high temperature and general malaise. After the reaction has subsided considerable improvement is often apparent, but this is only temporary in character, and the condition sooner or later returns with increased severity.

In almost every instance of mediastinal tumors that have come under observation the rate of growth has been very markedly checked by the use of radium, and in one or two cases a definite decrease in the size of the tumor, as seen by X-ray screening, has undoubtedly occurred.

If the condition be accompanied by an accumulation of fluid in the pleura and paracentesis be performed, radium appears to exert a very remarkable action in lessening the tendency of the production of further effusion.

In fibroid diseases of the uterus radium exerts a most beneficial action upon the distressing symptoms, menorrhagia and metrorrhagia, which are the almost invariable concomitants of this condition, though it seldom produces any very great diminution in the size of the uterus.

Leucoplakia patches on the tongue, cheek, or vulva are speedily removed by radium, but they tend to recur sooner or later.

Before expressing an opinion as to the possibility of radium treatment effecting an improvement in any particular instance of flat superficial naevi, capillary naevi "port wine stains," etc., it is advisable to subject the lesion to diascopy. If blanching is readily effected by gentle pressure, the result of the treatment will probably be satisfactory; but if it be found impossible to produce blanching except by great pressure, it is unlikely that radium can do much for the condition.

Infinite patience is necessary in the treatment of superficial naevi, and the utmost caution must be observed.

Cavernous naevi do excellently under radium, especially when of such shape that "cross fire" radiation is possible.

Warts and papilomata yield readily to short exposures of from twenty minutes to one hour's duration with half strength apparatus unscreened. The reaction is but slight and the resultant scar scarcely noticeable.

Tuberculosis of Glands.—In cases in which surgical measures have been declined for cosmetic reasons, radium often proves of considerable value, either when used alone or as an adjunct to vaccine treatment.

Lupus Vulgaris.—As a routine treatment for this disease Finsen light is greatly to be preferred to radium, but where it fails to effect a cure or improvement radium sometimes proves of great use.

In spring catarrh the employment of radium is strongly to be advocated, as it will often cure the most intractable cases. Personal idiosyncrasy is, however, a very important consideration, and it is essential to proceed with great caution, giving short unscreened exposures at intervals of a fortnight, and carefully noting the reaction.

Keloids give most excellent results when treated with

radium, and a general improvement if not complete cure can be safely predicted. In tender and painful keloids the anaesthetic effect of radium is generally very marked, and appears very early in the treatment.

In the case of Lupus Erythematosus, it has been found that this decidedly intractable and puzzling disease often responds favorably to radium, even after all routine methods have failed.

Psoriasis and Chronic Eczema.—Both of these conditions generally yield readily to short unscreened exposures of from two to five minutes' duration, given on three successive days, the series of exposures being repeated at intervals of a fortnight. The patches quickly disappear after a slight superficial reaction, and in eczematous cases there is but little tendency to recurrence. With psoriasis, however, the disease almost invariably reappears after a time, though with some patients the interval that elapses may be of many months' duration.

Lichenification of the skin, with its attendant intolerable itching, is quickly relieved and often completely cured by one exposure of ten or fifteen minutes' duration to a half strength applicator screened with 0.01 millimeter of aluminium.

Pruritus.—The analgesic effect of radium is often of the greatest use in this disease, and short unscreened exposures frequently produce a degree of relief which is unattainable by any other measure. This is especially noticeable if the pruritus occur in association with a definite lesion such as leucoplakia or hyperkeratosis.

Few patients suffering from exophthalmic goiter have as yet been treated at the Institute, but the results obtained are sufficient to justify a trial of radium when other treatments have failed to produce any result.

Arthritis Deformans.—The daily administration of 250 cubic centimeters of radium emanation solution of a strength of not less than 1 millicurie per liter to patients suffering from this obstinate and painful disease is sometimes attended by very remarkable results. It is difficult to predict with certainty the degree of improvement likely to occur in any particular instance, but the cases which appear to derive most benefit are those in which the disease is of relatively short duration, and the changes are periarticular in type and multiarticular in distribution. The age of the patient also exerts some influence, those under 40 responding more quickly to the action of the emanation. Cases with a definite gouty history sometimes experience an acute exacerbation of all their symptoms within the first week or ten days of their treatment, but this disturbance is quite transient, and is usually followed by a distinct change for the better.

Little or no improvement can be looked for in instances where cartilaginous or osseous changes are predominant, and the radium emanation solution is powerless to bring about the absorption of osteophytic growths or the loosening of fibrous or bony ankylosis.

When limitation of movement is due to periarticular fibrous thickening considerable increase of mobility often follows on the taking of the radium water and enables patients to perform actions, such as feeding themselves, brushing their hair, shaving, etc., which they may have been powerless to do for some months or even years.

Other favorable effects of the treatment are the lessening or disappearance of the muscular and articular pains, the grating of the joints on movement is not so marked, the muscles regain much of their lost tone, and the patient's general health is much improved. This is especially noticeable when the patients are suffering from anaemia, the haemoglobin index being rapidly increased.

Much research work has yet to be undertaken to enable an accurate opinion to be formed of the manner in which radium emanation solution produces these results, as its action appears to be a multiple and highly complex one, but the reinforcing of the body ferments, the increase of tissue oxidation, and the dissolving uric acid are undoubtedly factors which contribute to its success.

TABULATED REPORT OF THE LONDON RADIUM INSTITUTE.

| | Examined but not Treated. | Results Not Yet Noted | Prophylactic Treatment Only | Apparently Cured | Cured | Improved | Not Improved | Abandoned Treatment | Dead | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| **Adenoma of thyroid** | 1 | 2 | .. | .. | .. | . | .. | .. | .. | 3 |
| **Fibromata** | 3 | .. | .. | .. | 1 | 3 | 2 | 1 | .. | 10 |
| **Fibroid disease of uterus** | .. | 1 | .. | .. | .. | 6 | .. | .. | .. | 7 |
| **Leucoplakia** | 2 | .. | .. | 1 | .. | 2 | .. | .. | .. | 5 |
| **Naevi** | | | | | | | | | | |
| Capillary | .. | 4 | ... | .. | 1 | 19 | 1 | . | .. | 25 |
| Cavernous | 1 | 1 | .. | .. | 2 | 8 | 2 | .. | .. | 14 |
| **Moles, warts and papillomata** | 1 | 2 | .. | .. | 8 | 6 | 1 | .. | .. | 18 |
| **Tuberculosis** | | | | | | | | | | |
| Glands | .. | .. | .. | 1 | .. | 2 | .. | .. | .. | 3 |
| Skin | 1 | .. | .. | .. | .. | 5 | .. | .. | .. | 6 |
| Conjunctiva | 1 | .. | .. | .. | .. | .. | .. | .. | .. | 1 |
| **Spring Catarrh** | .. | .. | .. | 1 | .. | 1 | .. | .. | .. | 2 |
| **Chronic inflammations** | 1 | 1 | .. | .. | 2 | 3 | .. | .. | .. | 7 |
| **Chronic ulcerations** | 1 | .. | .. | .. | 1 | 6 | 1 | .. | .. | 9 |
| **SKIN DISEASES—** | | | | | | | | | | |
| **Keloid and vicious cicatrices** | 2 | 2 | .. | 2 | .. | 10 | 1 | .. | .. | 17 |
| **Lupus erpthematosus** | .. | .. | .. | .. | .. | 6 | .. | .. | .. | 6 |
| **Psoriasis** | .. | 1 | .. | .. | .. | 4 | 2 | .. | .. | 7 |
| **Pruritus** | .. | 2 | .. | .. | 2 | 2 | 2 | .. | .. | 8 |
| **Chronic eczema** | .. | .. | .. | .. | .. | 3 | 1 | .. | .. | 4 |
| **Lichenification of skin** | .. | .. | .. | .. | .. | 1 | .. | .. | .. | 1 |
| **Mycosis fungoides** | .. | .. | .. | .. | .. | 1 | .. | .. | .. | 1 |
| **Roentgen-ray dermatitis** | .. | .. | .. | .. | .. | .. | 1 | .. | .. | 1 |
| **Telangiectasis** | .. | .. | .. | .. | .. | 1 | .. | .. | .. | 1 |
| **Hypertrichosis** | .. | .. | .. | .. | .. | .. | 1 | .. | .. | 1 |
| **GENERAL DISEASES—** | | | | | | | | | | |
| **Arterio-sclerosis** | 3 | 1 | .. | .. | .. | 2 | 1 | 1 | .. | 8 |
| **Exophthalmic goitre** | 1 | 1 | .. | .. | .. | 4 | .. | .. | .. | 6 |
| **Myelogenous leukaemia** | .. | .. | .. | .. | .. | 1 | .. | .. | .. | 1 |
| **Myasthenia gravis** | .. | .. | .. | .. | .. | .. | 1 | .. | .. | 1 |
| **Neurasthenia** | 1 | .. | .. | .. | .. | 2 | .. | 3 | .. | 6 |
| **Neuritis** | 6 | 5 | .. | .. | .. | 5 | 3 | .. | .. | 19 |
| **Gout** | .. | 2 | .. | .. | .. | 3 | .. | 2 | .. | 7 |
| **Neuralgias** | .. | 2 | .. | 1 | .. | 2 | 1 | .. | .. | 6 |
| **Rheumatism** | 3 | 2 | .. | .. | .. | 1 | .. | 3 | .. | 9 |
| **Arthritis deformans** | 41 | 69 | . | .. | .. | 47 | 39 | 8 | .. | 204 |
| **Totals** | 112 | 176 | 30 | 56 | 18 | 341 | 152 | 50 | 37 | 972 |

| | Examined but not Treated. | Results Not Yet Noted | Prophylactic Treatment Only | Apparently Cured | Cured | Improved | Not Improved | Abandoned Treatment | Dead | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| **CARCINOMA. Squamouscelled.** | | | | | | | | | | |
| **Glabrous skin** | 1 | .. | 1 | 2 | .. | 4 | 4 | 1 | .. | 13 |
| **Buccal, oral, lingual and pharyngeal mucous membranes** | 6 | 10 | 6 | .. | .. | 9 | 15 | 3 | 4 | 53 |
| **Oesophagus** | 5 | .. | .. | .. | .. | 4 | 4 | 1 | .. | 14 |
| **Larynx** | 1 | 2 | .. | .. | .. | 1 | .. | .. | .. | 4 |
| **Vagina and vulva** | .. | .. | 1 | 1 | .. | 3 | 1 | 1 | 1 | 8 |
| **Uterus** | .. | 2 | 2 | .. | .. | 27 | 8 | 1 | 2 | 42 |
| **Penis** | .. | .. | .. | .. | .. | .. | 1 | .. | .. | 1 |
| **Bladder** | .. | .. | .. | 3 | .. | 3 | .. | 1 | 2 | 9 |
| **Carcinoma, spheroidal celled** | | | | | | | | | | |
| **Breast** | 11 | 22 | 11 | 2 | .. | 40 | 19 | 11 | 12 | 128 |
| **Liver and gall bladder** | .. | .. | .. | .. | .. | 1 | .. | .. | .. | 1 |
| **Thyroid** | .. | .. | .. | .. | .. | 3 | .. | .. | 1 | 4 |
| **Paget's disease** | .. | .. | .. | 1 | .. | .. | .. | .. | .. | 1 |
| **Carcinoma columnar-celled—** | | | | | | | | | | |
| **Large intestine** | 1 | 4 | 2 | .. | .. | .. | .. | 1 | 1 | 9 |
| **Rectum** | 9 | 9 | 1 | .. | .. | 23 | 16 | .. | 6 | 64 |
| **Stomach** | .. | .. | .. | .. | .. | 1 | 1 | 1 | .. | 3 |
| **Ovary** | .. | 2 | .. | .. | .. | .. | 1 | .. | 2 | 5 |
| **Prostate** | 1 | .. | .. | .. | .. | 4 | .. | .. | .. | 5 |
| **Kidney and suprarenal gland** | .. | 1 | .. | .. | .. | .. | .. | 1 | .. | 2 |
| **Parotid** | .. | .. | .. | .. | .. | .. | 1 | .. | .. | 1 |
| **Rodent Ulcer** | 4 | 21 | 2 | 40 | .. | 34 | 7 | 3 | .. | 111 |
| **SARCOMATA** | | | | | | | | | | |
| **Spindle-celled** | 1 | .. | 1 | 1 | .. | 8 | 4 | 1 | 1 | 17 |
| **Round-celled** | 1 | .. | .. | .. | .. | 1 | .. | .. | 1 | 3 |
| **Melanotic** | .. | .. | 1 | .. | .. | .. | 1 | .. | .. | 2 |
| **Myelosarcoma** | 1 | .. | .. | .. | .. | 1 | .. | .. | .. | 2 |
| **Lymphosarcoma** | .. | 1 | .. | .. | .. | 2 | .. | .. | .. | 3 |
| **Endothelioma** | .. | 2 | 2 | .. | .. | 2 | 2 | 1 | 1 | 10 |
| **Lymphadenoma** | .. | .. | .. | .. | .. | 4 | 2 | 1 | .. | 7 |
| **Malignant glands** | 1 | 1 | .. | .. | .. | .. | 2 | 3 | 2 | 13 |
| **Parotid tumour** | .. | .. | .. | .. | .. | .. | 1 | .. | .. | 1 |
| **Abdominal tumour** | .. | .. | .. | .. | .. | .. | 1 | .. | 1 | 2 |
| **Mediastinal tumour** | .. | 1 | .. | .. | .. | 4 | . | 1 | .. | 6 |
| **Villous tumour of bladder** | .. | .. | .. | .. | .. | 2 | 1 | .. | .. | 3 |
| **Polypi of vagina** | .. | .. | .. | .. | 1 | .. | .. | .. | .. | 1 |

## Protecting Canal Bottoms Against the Erosions Caused by the Use of Screw-Propelled Vessels

**By Our Berlin Correspondent.**

It is a fact of common knowledge that the bottom of a canal is affected in a high degree by screw-tug operation. In the center there is considerable erosion, the washed-out sand forming on both sides obstructions which must be removed by costly dredging, in order to restore the profile of the canal.

As regards the cause to which canal erosion is due, there is at present general agreement that the phenomenon is mainly to be ascribed to the joint effect of the propeller screw and rudder. The screw draws in the water peripherally in a forward direction, and after accelerating it, allows it to flow off backward, in a motion at first cylindrical, and afterward divergent (spiral), comprising a rotating and an axial component.

Tests made by Dr. Gebers for the Prussian Department of Public Work have brought out the prominent part played in this connection by the rudder. A rudder arranged behind the propeller screw was found to deflect part of the rotating water downward, i. e., toward the canal bottom, thus producing erosion. He therefore suggested that this effect should be prevented by providing, to the right and left, respectively, of the propeller screw, two rudders reaching only as far as the boss of the screw in a downward direction and thus eliminating any deflection of the rotating water particles.

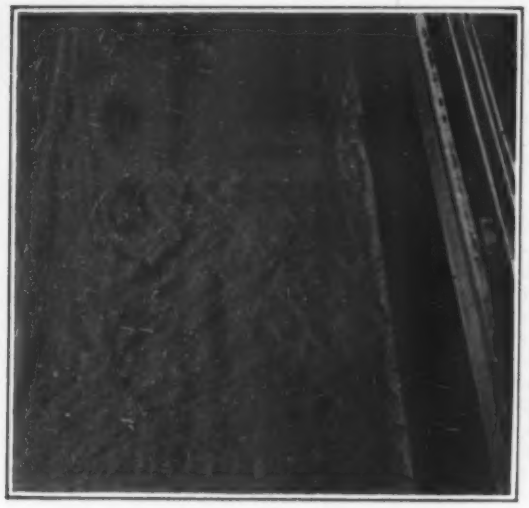
In accordance with this suggestion, the Prussian government has ordered all canal steamers to be fitted with twin rudders, though this arrangement affords a partial protection only as long as the rudder is held accurately amidships. In fact, as soon as the rudder is turned, thus entering the flow around the screw, there is a considerable erosion of the canal bottom, and since the rudder is intended for use in steering, the benefit to be derived from Dr. Gebers's scheme is quite illusory.

Privy Councilor O. Flamm, the well-known German authority on shipbuilding, who first enunciated this opinion, therefore decided to investigate the problem more closely in his private experimental tank at the Charlottenburg Technical High School. A propeller screw was arranged to work on a very light sand bottom, in conjunction with a series of rudders tested in succession. Photographic views were taken during operation, through the water, which was lighted by means of huge naval searchlights, the sand bed being tested photographically after each experiment.

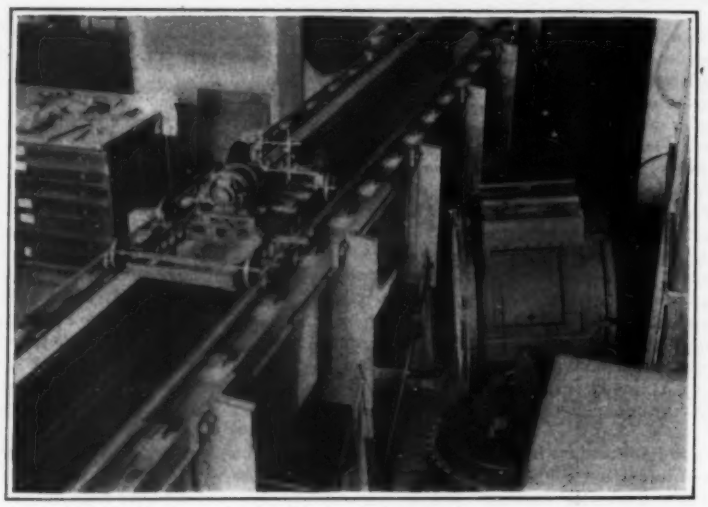
The results thus obtained are extremely interesting, and bear out completely the experimenter's views. Kinematograph films were prepared, which demonstrate the phenomena at issue in a striking manner. Recent tests at the Royal Testing Office for Marine Engineering and Shipbuilding (Charlottenburg) fully confirm Prof. Flamm's results.

After three years' experimenting, Prof. Flamm suggests the following solution of the problem: If a horizontal plate be fitted to the lower part of an ordinary rudder, the water lines deflected downward from the vertical part of the rudder are likely to be further deflected in a horizontal direction, thus not striking the canal bottom. In order to ascertain whether this hypothesis is true, Flamm ordered an extensive series of model experiments to be made at the Royal Testing Office, on rudders of the most varied kinds.

Most careful experiments on a large scale were then undertaken on three vessels, in the name of the Prussian government, by the Fürstenwalde Department of Hydraulic Engineering, each individual test (lasting



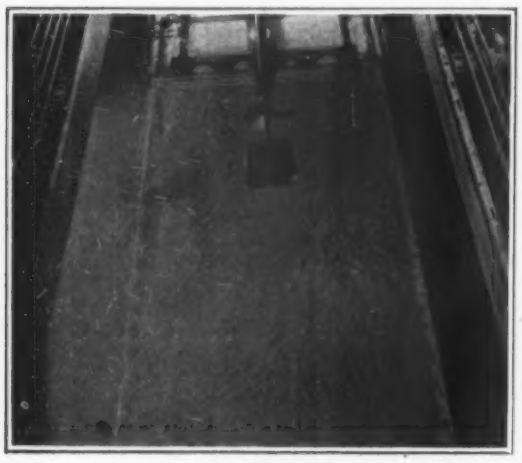
Propeller without rudder, 440 revolutions, duration one minute.



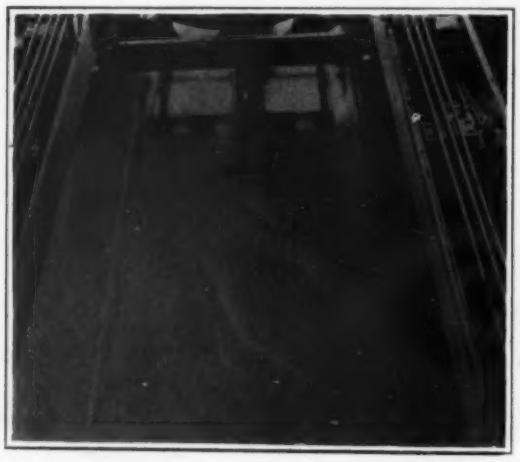
General layout of the apparatus employed in the investigation.

# Protecting Canal Beds from Injury from Screw Propellers

*Much injury is frequently done to canal beds by the passage of screw propellers, particularly in those portions where there is considerable variation in depth of water and where the formation of the bottom is such that serious injury was for a long time thought to be caused by the propeller. Experiments shown in the accompanying illustrations demonstrate the direction of the current from the rudder that causes the trouble by displacing the bottom from the propeller. The experiments were made with a simple plate applied to the rudder of any craft operating in narrow*



Influence of the protecting plates upon the canal bottom.



Simple rudder without plates, at angle of 30 degrees with axis of propeller.

Single rudder with plate, at 30-degree angle with axis of propeller.

Violent t

Single rudder without plate, at angle of 30 degrees with axis of propeller. Shows stream lines deflected by rudder behind propeller; 530 revolutions per minute. Duration of experiment, 30 seconds. Pit, 15 mm. deep.

Single rudder with plate; 30 degrees to the axis of propeller. Shows stream lines deflected upward by the protecting plate. Revolutions per minute, 440. Duration of experiment, one minute.

Double rudder without plates, placed centrally. Distance between rudders, 180 mm; 530 revolutions per minute. Duration of experiment, 30 seconds. Very violent and irregular rippling of entire surface. Pit, 4 mm. deep.

Double ru
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Double rudder without plates. Placed high in central position. Distance between rudders, 120 mm. Number of revolutions per minute, 550. Duration of experiment, 30 seconds. Modest rippling of the sand surface.

Double rudder with plates. Placed high in central position. Distance between rudders, 120 mm. Number of revolutions, 550. Duration of experiment, 30 seconds. Practically no rippling of the sand surface.

Double rudder without plates, placed high at 30 degrees with axis of propeller. Distance between rudders, 120 mm.; 550 revolutions per minute. Duration of experiments, 30 seconds. Very strong turbulation of the sand.

Double rudde
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# ng Canal Bottoms njury from Screw Propellers

*...y done to ... by the passage of boats driven by ...larly in the... ...ons where the erosion results in ...le pth of ... the formation of bars, not to speak ...akening the... that serious leakage occurs. This ...e thought ... by the propeller, but the exper- ...mpensing ...ations demonstrate that it is the ...uble by ... the direction of the flow of water ...experiments ...how a simple remedy that can be ...any craft ... in narrow or shallow channels.*

Propeller with air spirals.

Turbulation by the propeller with rudder and without protecting plates.

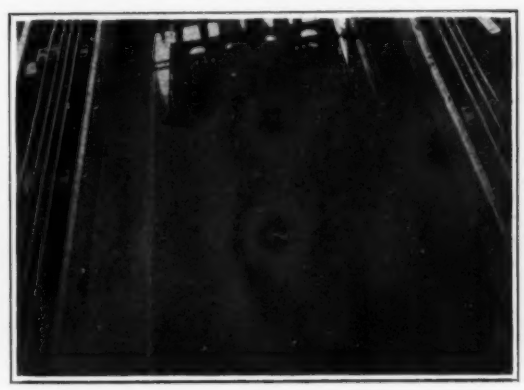
Violent turbulation of the sand and formation of ripples.

Slight turbulation of the sand and slight formation of ripples.

Single rudder in central position, without plate, shows stream line deflected by rudder.

Double rudder with plates. Deep and in central position. Distance between rudders, 180 mm. Number of revolutions per minute, 560. Duration of experiment, 30 seconds. Slight rippling of sand. No pit formed.

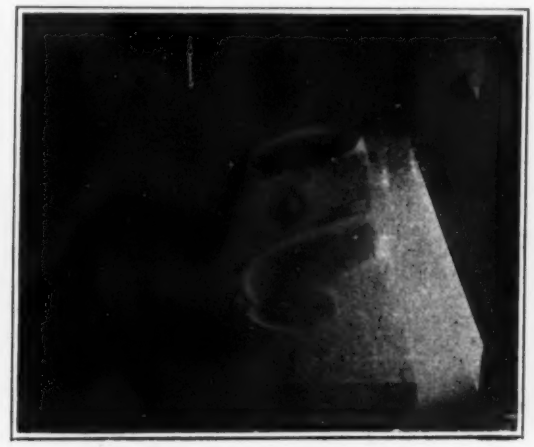
Double rudder without plate. Deep; 30 degrees from central line. Distance between rudders, 180 mm. Number of revolutions per minute. 530. Duration of experiment, 30 seconds. Strong rippling of sands. Pit, 4 mm. deep.



Double rudder with plates. Deep; 30 degrees from central position. Distance between rudders, 180 mm.; 560 revolutions per minute. Duration of experiment. 30 seconds. Hardly any rippling of the sand and no pit formed.

...uble rudder with plates placed high, 32-degree ...gle with axis of rudder. Distance between rud- ...ers, 120 mm. Number of revolutions, 550 per ...inute. Experiment, 30 seconds. Slight rippling ...f surface sand and no pit formed.

Double rudder placed deep (represented by single rudder on starboard), without plates, 45 degrees angle with axis of propeller; 530 revolutions per minute. Experiment, 1 minute 10 seconds. Violent turbulation of sand, and pits 23 mm. deep.



In foreground formation of pit, 55 mm. deep. In background a second experiment, carried out under same conditions as third previous figure, showing same result as regards form and character of pit forms.

fully two hours) being duplicated, in order to eliminate any accidental circumstances.

The profile of the experimental track (40 meters in length for each individual test, viz., 10 meters in front of and 30 meters behind the screw) was gaged carefully at intervals of 1 meter apart, by means of a raft 2 meters in width reaching across the canal section, thirty-one points being measured in each profile. This necessitated a total of about 30,000 readings. The vessels were moored in the middle of the canal and made to work in this position, indicator diagrams being taken continually, the number of turns being gaged, and the dynamometer traction read permanently. The most remarkable results obtained in this manner are summarized in the following:

The first set of tests was made on the steamship "Cæsar Wollheim VI," a single-screw vessel of 160 indicated horse-power, which had been fitted with the protective plate. The steamer worked for two hours, twice, without developing any appreciable erosion of the canal bottom.

Another test was made on the Diesel motor vessel "Cladow" (90 indicated horse-power), the screw of which, *after dismounting the rudder*, was allowed to work for twice two hours at its normal speed of 280 revolutions per minute, without there being any measurable erosion.

After thus confirming Prof. Flamm's theory, that erosion is due exclusively to the deflection, by the rudder, of the water jets thrown backward by the screw, the rudder fitted with the protective plate was placed in position, and the screw was again made to work twice for two hours. In spite of the most conscientious gaging of the canal bottom no trace of an appreciable erosion could be detected.

After then removing the protective plate, the screw was allowed to work with the same rudder as before, when enormous holes about 1.50 meters in depth were washed out of the canal bottom. It may be said that the draft of the vessel, in connection with these experiments, was 1.4 meters, and the water level in the canal about 3.20 meters, so that there were 1.80 meters of water left below the vessel and 1.90 meters below the lower edge of the propeller vanes.

A third set of tests was made on the Oder-Spree Canal with the steam tug "Dora," known to exert very strong erosive effects. This having been fitted with Flamm's protective plate, the screw was allowed to work twice for two hours, without there being an appreciable erosion. The plate was then removed and the screw allowed to work another two hours, when an excavation about 11 meters in length, 12 meters in width, and 1.61 meters in depth was produced.

Samples of the soil derived after the plate test, by means of big glass tubes, showed the clay layer to have remained unaffected, even the light mud on top of this layer being intact.

Another set of tests made with the freight steamer "Fritz," fitted with the protective plate, led to the following results. Behind the ship there was no erosion, only a small hole being produced below the propeller screw, by the suction effect of the latter.

From these results it is inferred that the plate, if properly dimensioned and conveniently arranged, affords full protection to the canal bottom, one of the most striking features being the absolute agreement between the model tests and experiments made under actual working conditions.

Further experiments were carried out in Prof. Flamm's experimental tank at the Charlottenburg Technical High School on all kinds of rudders as used in actual practice, with ships at rest as well as in motion.

Ordinary rudders were found to produce very considerable erosion, irrespective of their position. Screws without rudder likewise produced at least some erosion. Twin rudders introduced into the propeller current would, in their turn, give rise to heavy erosion. Erosion, however, ceased completely in all these cases, as soon as the rudder was fitted with the protective plate.

This simple safeguard thus affords an inexpensive means of preventing any damage to the canal bottom, and as the plate, moreover, augments considerably the steering capacity of the vessel, it will doubtless prove a welcome addition to present means of navigation. One question suggests itself, whether with these rudder plates the deflected current would not tend to depress the stern of a light boat.

Further experiments on a still larger scale, which are now in progress, bear out completely the above conclusions.

## The Propulsion of Submarines

### German and French Practice

THE problems associated with the propulsion of vessels of the submarine class are of the greatest interest and call for the display of considerable ingenuity on the part of the engineer in combining the demands of the tacticians for speed, radius of action, capacity for maneuvering, and quick diving qualities with the allotment of the minimum space and weight. The change in propulsive machinery within recent years from gasoline and kerosene engines to those working on the Diesel cycle has made for greatly reduced dangers from the ignition of explosive mixtures of fuel vapor and air, and has increased to a considerable extent the radius of action. The Diesel engine being of German origin, it is natural that its adaptation to the propulsion of submarines—duties for which it is eminently suited—was early undertaken in Germany. The two German firms who have built the greater part of the engines of this type for German submarines are Krupps and the Maschinenfabrik, Augsburg-Nürnberg firms. Both firms have made many experiments in order to evolve the most suitable type of engine, and preference is apparently given to the two-cycle engine, although the M.A.N. firm also build successfully a four-cycle submarine engine which, from the official published data of tests of various types of high-speed Diesel engines, would seem to be well fitted for this kind of work.

TWO-STROKE ENGINES.

The firm of Krupp have specialized in the two-stroke cycle engine, and the method of scavenging they have adopted is by means of three valves in the cylinder head. The number of valves required for efficient scavenging is a moot point, and two are now generally regarded as sufficient. A greater number would doubtless conduce to the better clearing out of the burnt gases and the charging of the cylinder with fresh clean air, but the ensuing complications of valve gear generally call for the compromise of a smaller number of valves. For actuating the three-cylinder head valves Messrs. Krupp have designed a very neat valve gear, which has the virtue of simplicity. The fuel valve in the cylinder head of these engines is not vertical, but is inclined inboard to facilitate dismantling and to diminish the amount of head room required. The cylinders, liners, and heads are three separate castings, although the cylinder jackets are sometimes incorporated in the crank-case steel or bronze casting, which is made sufficiently strong to take the tension load.

In this engine the general arrangement is unique. In the center is the high-pressure three-stage compressor, on each side of which are grouped three working cylinders, while at the extreme end are double acting scavenging pumps. The provision of two scavenging pumps in comparison with the one usually adopted reduces the reciprocating weights of these parts and should make for a good balance. All these engines are directly reversible.

From the M.A.N. firm emanated the now famous two-stroke cycle stepped-piston type of engine, which type had for the main reason of its inception the reduction of weight and space occupied to an absolute minimum. The outstanding feature of design in this case lies in the form of the piston, which at its lower extremity is increased in diameter to form a crosshead to carry the gudgeon pin and to serve to compress the air necessary for scavenging. This piston works in a cast-iron liner let into the bronze crank-case, and the air is controlled by means of automatic valves. The advantages of this type of construction in reducing weight are considerable, and it is claimed that the weight works out at from 55 to 60 pounds per brake horse-power for engines of considerable size. The disadvantages are primarily those involved in the difficulty of successful piston design, since this part is subjected on the top to the hot action of the burning gases in the cylinder and at the bottom to the cooling effect of the scavenging air. This difficulty is now overcome by making the piston in two pieces.

In connection with the means of introducing the scavenging air into the working cylinder, it is interesting to record that the M.A.N. firm for their larger engines have discarded the single valve in the cylinder head in favor of two valves. The cylinders, again, in this design are cast in one piece—head, liner, and jacket. Two compressors with cranks in line are provided at the forward end of the engine to supply the air necessary for the injection of the fuel into the working cylinders and to charge the starting air bottles. This duplication aims at securing the reliability of one of the units of a modern Diesel engine that is calculated to give a certain amount of trouble. It must be realized that a breakdown of the compressor necessitates stopping the main engine, and the duplication referred to should probably enable the ship to proceed at almost full power assuming the breakdown of only one of the four compressors provided in a twin-screw vessel. These engines have been, it is believed, installed in German submarines, with eight cylinders giving 2,000 brake horse-power (250 brake horse-power per cylinder) or 4,000 brake horse-power per twin-screw vessel, which is the largest power so far adopted with oil engines of the light high-speed type—i. e., running at over 300 revolutions per minute.

M.A.N. FOUR-STROKE ENGINE.

This same firm at their Augsburg works have specialized in a four-stroke cycle engine, to the successful performance of which reference has already been made, and it is significant that, whereas drawings and information regarding the two-stroke cycle stepped piston engine of this firm have freely been given in the technical press of various countries, no detailed particulars whatsoever regarding the four-cycle engine are forthcoming. The 1,000 brake horse-power six-cylinder type, of which, it is believed, considerable numbers have been made, is remarkably light for its power, and the overall weight, especially when the extra fuel and lubricating oil consumptions of the two-stroke cycle engine are remembered, is little in excess of the two-stroke cycle engines previously described. Considerable ingenuity has been displayed in this design in fitting a neat reversing gear, as in foreign submarines equipped with Diesel engines direct reversibility is regarded as indispensable. The advantages of reversing the main engines are considerable when maneuvering; since the power developed by the main engines is always considerably in excess of that provided for by the electric motors installed for under-water propulsion. Again, the time necessary to reverse the main oil engines is not in excess of 10 seconds, which is very quick and considerably less than would be required to declutch the main engine and to reverse on the electric motor.

Besides these engines from the principal Diesel engine works in Germany, a large submarine is in hand at the works of the Italian constructors, the F.I.A.T. San Giorgio, in Spezia, and this submarine is to be propelled by engines of the well-known F.I.A.T. type of considerable horse-power. It is reported that these engines have successfully accomplished their bench trials, both for full power and for endurance. The two engines, it is stated, develop considerably over 2,500 brake horse-power. It may be mentioned that the dimensions of the latest type of German submarine are: Length, 213 feet 3 inches and beam, 20 feet. The displacement is 800 tons, and there are three torpedo tubes with two guns mounted forward.

THE USE OF STEAM.

The number of submarines actually built in Germany is given as 27, while 12 more are finished or in the course of construction. These numbers are much smaller than those for the French navy, which are given as 70 built and 23 building, the difference being due to the early pioneer work done by France in this movement. For the propulsion of the French submarines Diesel engines have not met with any considerable favor, and the majority of the boats are propelled by gasoline and kerosene engines. For the later boats steam turbines are being adopted. This propulsion by steam is not new, but is a reversion to early practice, which was abandoned in favor of internal combustion engines on account of the difficulties experienced in "closing down" the earlier boilers preparatory to diving and running below the surface on the electric motors. These difficulties, it is expected, will be overcome by the adoption of modern express water-tube boilers of rapid evaporative properties. Of these steam-driven submarines, four are being built at Rochefort of about 900 tons displacement, with twin screws driven through gearing by turbines of a total of 4,000 shaft horse-power, and two at Cherbourg of 950 tons displacement developing 5,000 shaft horse-power—the largest power yet applied to submarine propulsion. The results of this reversion to steam propulsion will be very closely watched by all submarine authorities, and if they are successful large developments in this direction may be expected in the near future. It is not to be understood that the French Navy have not applied Diesel engines to submarine propulsion, as in France a considerable number of boats are so propelled. The largest engine yet built is one of 2,000 brake horse-power, with eight cylinders.—*The Times*, London.

## The Protective Treatment Against Typhoid Fever*

TYPHOID fever is inseparable from war. It finds in war, ready for it, all that it could desire. In times of peace we have a thousand ways of avoiding it, a thousand ways of holding it up; so sure are our defenses, so elaborate our plans, that we get into a stupid way of thinking of typhoid fever as if it were due only to "insanitary surroundings"; as if it were a disease altogether unlikely to show itself within ten miles of a good medical health officer. Then comes war; and, with declaration of war, comes the general mobilization of the infective diseases. They are called

* Stephen Paget in *Nature*.

up, they are sent to the front. Louvain as it was and Louvain as it is are scarcely more alike than are typhoid in times of peace and typhoid in time of war.

Typhoid is, of course, already taking part in the present war. Given the allied armies and the German army in the western theater, how should there not be typhoid? The only question is, How much more will there be a month hence? The lateness of the year, happily, will kill off flies, which are great carriers of the disease; but the flies are not yet gone, and they will more or less repeat that deadly part which they took in the South African war. There is plenty of the disease for them to carry. "It is well known," says Sir Almroth Wright, in the *Times*, September 28th, "that the infection of typhoid is thickly sown all along the frontier of France and Germany." Besides, among two millions of men, there are bound to be some who have the germs of the disease in them. And what is the good of talking of "sanitation," as if our men could have the warm baths and the water-closets of the average Englishman's home? Let us take Dr. Johnson's advice, and clear our minds of cant. "An army," as Wright says, "on going out on active service goes from the sanitary conditions of civilization straight back to those of barbarism. . . . In war the doors are everywhere opened wide, both to the direct conveyance of infection by the excreta, and to its indirect conveyance by means of contaminated water. . . . On service, proper sanitary arrangements are very often impossible. We may think, for instance, of the situation of men in the trenches under fire. . . . When it comes to a tight place the alternative which will present itself will be that of drinking a polluted water or none. . . . It will, by the very nature of the case, be out of question to apply ordinary sanitary measures in an effective manner. . . . Infection spreads not only among the troops in the field, but also among the soldiers in hospital."

The *Daily Chronicle*, October 3rd, says: "It is reported that 800 Germans, on the lines between Brussels and Antwerp, are suffering from typhoid fever."

That the protective treatment is indeed protective we all know. It is the experience of the nations of the earth; and the whole world is agreed about it. France, India, Canada, the United States, Italy, let alone our enemies, are of one mind. Take only four instances:

1. *British Army in India.*—"The histories," as regards typhoid fever, of 19,314 soldiers, whose average period of service abroad was twenty months, were carefully followed, and every precaution possible was taken to verify the diagnosis bacteriologically. Of this number 10,378 were inoculated, and 8,936 not inoculated. The case incidence of typhoid fever among the inoculated was 5.39 per 1,000, and among the non-inoculated 30.4 per 1,000.—*Report of Anti-Typhoid Committee*, 1912.

2. *United States Army.*—"Inoculation was made compulsory in the American army in 1911, and has practically abolished the disease. In 1913 there were only three cases and no deaths in the entire army of over 90,000 men."—Sir W. Leishman, *British Medical Journal*, August 22nd, 1914.

3. *French Army.*—In 1912 typhoid broke out in the barracks at Avignon. Of 2,053 men, 1,366 were protected and 687 were not. The non-protected had 155 cases, with 21 deaths; the protected had not one case. The protective treatment was made compulsory last winter in the French army; and, in special circumstances, among the reservists.—*Lancet*, January 4th, 1913.

4. *Canadian-Pacific Railway.*—Throughout the "railways camps" in Alberta, during 1911, among 5,500 protected there were only two cases of typhoid; among 4,500 non-protected there were 220 cases.—*British Medical Journal*, June 6th, 1914.

It remains to be noted: (1) That the vaccine contains no living germs of any sort. (2) That the treatment, though it gave good results in the South African war, has been improved since that time. (3) That the avoidance of exertion and excitement, on the day of treatment, is a great safeguard against any disturbance of the general health. (4) That, when time allows, it is always best to give the vaccine not all in one dose, but in two, or even three graduated doses, with a few days between each dose.

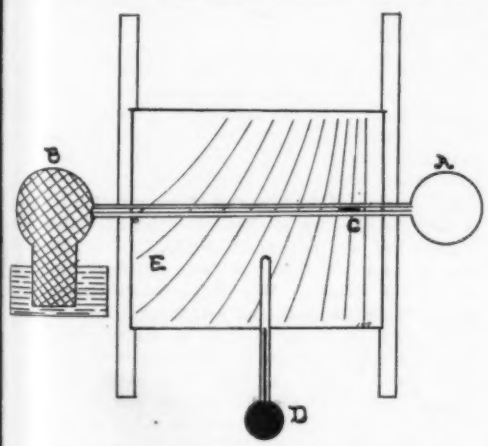
Sir Almroth Wright, by whose hands the gift of this treatment came to us, greatly desires that the treatment should be made compulsory, as in other armies, so in ours. Surely it is part of "my duty to my neighbor" that I should not, by having typhoid, expose him to the risk of infection from me. And it is certain that a soldier down with typhoid fever is not only useless against the enemy, but dangerous to his own friends.

## A Direct Reading Psychrometer

**By F. W. L. Peebles**

Every weather bureau observatory uses a "wet and dry bulb" thermometer for the determination of the relative humidity of the atmosphere. The standard instrument is made up of two ordinary thermometers, as nearly alike as possible. One of them has the bulb covered with wicking which dips in water so as to keep the bulb wet. Water on the wet bulb evaporates and cools the mercury thus recording a lower temperature. The drier the air, the greater will be the evaporation and consequent reduction of temperature on the wet bulb side. The relative humidity of the air is computed from this difference. The capacity of the air for moisture varies with the temperature so that tables are necessary for the determination.

In the present instrument, which was designed by the writer, the use of tables has been eliminated and the




**A Direct Reading Psychrometer.**

readings are taken in per cent direct without any computation. Although it is believed that the device is original, it will not be patented, but rather, is hereby contributed to meteorological science by the designer.

In the figure *A* is the dry bulb of an air thermometer, *B* is the wet bulb, *C* is a plug of mercury, *D* is an ordinary mercury thermometer for determining the air temperature and setting the sliding scale, and *E* is a calibrated chart for taking the reading. The wick of the wet bulb is provided with a reservoir of water so that the bulb may be kept continuously wet. The sliding scale is set with reference to the thermometer *D* so that a gauge point on it may be brought to the level of the top of the column thus setting the calibrated chart for the temperature of the air when the observation is made.

If both bulbs are dry the indicating end of the plug of mercury will register with the line marked 100 per cent. This would be interpreted to mean that no evaporation is taking place; and, as far as the instrument is concerned, that the bulbs are both at the same temperature. Under this condition the position of the plug is the same for all temperatures of the air and consequently the 100 per cent line is vertical on the chart. When evaporation does take place the plug moves in a direction toward the cooler bulb, and this movement is a function both of the difference in temperature and of the absolute temperature of the outside air.

In order to eliminate the part that the temperature of the outside air plays, the sliding scale is adjusted to the height of the column of mercury in the auxiliary thermometer *D*. It may be well to note that such an arrangement is not a true differential thermometer, on account of the fact that the same difference in temperature will cause more motion of the plug when both are at low temperatures than when at high temperatures. This feature is particularly desirable on account of the greater capacity of the air at high temperatures than at low temperatures.

In making up the instrument it is desirable that it be filled with a gas that is inert to mercury so that the plug is not acted upon in time. The bore of the connecting tube should be proportioned to the size of the bulbs so as to secure the right amount of motion to the plug. The tube should be of uniform cross section and the plug short so as to make the friction negligible.

In making up the instrument one bulb is sealed onto the tube and closed by the sealing, leaving only the opening to the tube. The second bulb is then sealed to the other end of the tube but this bulb is left with a tail to be sealed off later. The whole system is then filled with the gas desired and a drop of mercury is added for the plug. The tail is now closed at some distance from the bulb and then this tail is sealed off near the bulb. The bulb that has the sealing end on it may now be used for the wet bulb end so that the wick will cover the point of closure.

To adjust the plug the dry bulb is held uppermost and in contact with the palm of the hand so that some of the gas is driven into the other bulb. The apparatus is then inverted so that the mercury can enter the tube and the heated bulb allowed to cool so that the gas in the cooler bulb may enter the tube and drive the plug along before it. When the two bulbs attain the same temperature the plug will come to rest. Should its position not be correct this may be changed by driving it back and using more or less heat as the case may be.

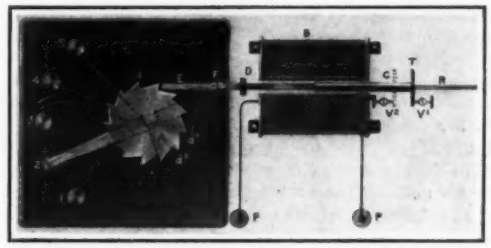
To calibrate the chart it is recommended that this be done by comparison with standard wet and dry thermometers and the table, although for those who have time for the mathematics it is easy to calculate the movement of the plug for different temperatures and differences in temperature of the two bulbs, and from this it is easy to calculate the relative humidity for any position of the plug. The rules for these computations may be found in any good text book in Physics.

## A Device for Regulating Storage Batteries from a Distance*

During the discharge of a storage battery the voltage gradually diminishes, so that, in order to maintain the constancy of lamps fed by the battery, it is necessary to add a cell (or to cut one out, if the cells are connected in opposition) whenever the drop in voltage amounts to about two volts. This is usually done by moving a multiple commutator on the switchboard, an operation that involves considerable trouble when the switchboard is located in the cellar or in a distant part of the building. A reliable and easily constructed device for operating the commutator from a distance by pressing a button is here shown. To the arm of the commutator is attached a disk, in the edge of which teeth of the shape illustrated have been cut with a fine saw or a file. The angle $d_1Od_2$, subtended at the center of the disk by each tooth, is equal to the angle $5O4$, through which the commutator turns in passing from one contact to the next.

The sucking coil *B* is constructed as follows: The central tube is made of brass and is of square section, in order to prevent the square rod *DC* that slides inside it from turning. The end pieces are of thick sheet brass, and have projections which are bent at right angles and perforated for the reception of screws by which the coil is fastened to the board. The winding contains about 1,200 feet of wire 1/60 inch in diameter. The sliding rod is composed of an iron segment *C* and two brass segments, *D* and *E*. The iron is attached rigidly to the brass, but the two brass segments are joined at *F* by a flexible hinge, which allows the segment *E* to be lifted easily.

When a current flows in the coil the iron rod is




**A device for regulating storage batteries from a distance.**

drawn into the coil, carrying the brass rods before it. In this movement the rod *E* strikes a tooth of the disk and turns the disk through the angular interval between consecutive teeth, causing the commutator arm to advance from one contact to the next. When the current ceases the compound rod is drawn back by the spring *R*.

In this reverse motion the hinged segment *E* rises above the next tooth and falls behind it, ready to push it forward when the current is again applied. The travel of the rod is limited by its cross-head *T* striking the screw-tops $V_1$ and $V_2$, which are so adjusted that the commutator arm stops exactly in the middle of each commutator contact, and the end of the hinged segment *E* falls behind the tooth with sufficient clearance.

The current may be taken from the storage battery itself by means of a branch circuit which includes as many cells as are required to energize the coil and turn the commutator. This circuit may be connected by very well insulated wires to push-buttons placed wherever they are wanted. When the lights grow dim another cell can be added to the battery by pressing a button. As the arm of the commutator is narrower than the space between consecutive contacts, the fact that the apparatus has operated is made evident, not only by the increase in brightness of the lamp, but also by the slight tremor in the light caused by the momentary interruption of the current.

* From *La Nature*.

First life class making gardens.

Life class studying erosion.

# An Experiment in Organic Education

## Making the Course of Study Fit the Child

### By Sidonie Matzner Gruenberg

WHILE we are waiting for Dr. Maria Montessori to try out her methods (SCIENTIFIC AMERICAN, June 22nd, 1912, page 564) with older children, we are informed that essentially the same principles have been applied in this country for seven years past, to groups of children from the kindergarten into the high school.

Mrs. Marietta L. Johnson, who worked on the theory and the methods of this experiment, was for years a teacher in a "regular school" in the West. Then she was a critic teacher in a training school and head of a department in a normal school. For a number of years after her marriage she did no teaching, but she apparently kept on thinking; for when it was time for her son to go to school she was unwilling to submit him to the "discipline" that she had seen imposed on thousands of other children.

Her reflections on the methods and the results of the ordinary schooling convinced her that our schools are fundamentally wrong. When an opportunity offered itself at Fairhope, Ala., to start a small class for her own child and the children of some of the neighbors, she resolved to abandon the classical methods in which she had been drilled and in which she had drilled other teachers, and to apply her deductions from certain modern scientific ideas. Mrs. Johnson traces the revolution in her outlook to two books that she read during the years of her children's infancy. These are Oppenheim's "The Development of the Child" and Henderson's "Education and the Larger Life."

The fundamental idea in the "organic" system of education is that "development is the only true education." As an organism the child in his development passes through fairly definite stages, in each of which certain instincts and needs are prominent. The school should therefore seek to meet the requirements of the child in each stage; thus alone can his further development be assured. Theoretically, all schools follow this principle. But Mrs. Johnson is the only educator in this country who has consistently followed this through all the grades, and on all sides of the child's nature and in connection with all of the school's work.

In the early years the child's instincts call for freedom and much activity; Mrs. Johnson keeps the children out of doors as much as possible and lets them do everything that children of that age care to do. Since the large muscles develop before the smaller ones, and since control can be best acquired when the muscles are developing, the younger children in the organic school are engaged in gardening, gymnastics, stone-throwing and other games, long before writing is thought of. The instinct to *make* things is exercised by opportunities to work in clay, clay-board, water-colors, and weaving. That younger children are far-sighted is recognized in the character of the activities, and no close work is put before them.

All these things sound very much like what is being done in thousands of other schools in this country and abroad. But these things are done in other schools spasmodically and as features added to the traditional course of study. Here they constitute the very heart of the course of study. Mrs. Johnson has done exactly what progressive educators have for years told us should be done, namely, she has made the course of study fit the child instead of trying to make the child fit the course of study.

Instead of making requirements for the child to meet, the organic school accepts each child as a personality and offers him an opportunity to do the best he can every day. The best of one child is not the same as the best of another child; one excels in this direction, another in that. And every child has more power in one direction than he has in another. Mrs. Johnson does not brand a child as stupid because he is weaker in arithmetic than his neighbors or because he is slower in a running match. "The test of the school," she says, "is the condition of the child. If every child is happy and busy and healthy, all is well.

This idea of free opportunity for doing the interesting thing because that is the educative thing, is carried so far that the school keeps no record of grades or achievement or attendance or promotions. Every child is promoted every year, or rather the promotion is continuous; every child does the best that he can and stays with his own group, instead of being obliged to repeat experiences from which he can probably not learn any more than he has already learned. There is no truancy problem, notwithstanding the absence of a compulsory attendance law, because there is no temptation to stay away from school. When the school is the most interesting part of the child's experience, he will naturally go to school whenever he is allowed to.

The absence of grading and of examination suggests to most people the absence of standards. But Mrs. Johnson has very definite standards, although they are not the same as those we have acquired from the schools and colleges. Mrs. Johnson's standards are a healthy body, an alert and active mind, and a sweet spirit. And all of the work at the Fairhope School is planned to produce these three sets of results.

For the health of the body there is an out-of-door activity adapted to the development and the strength and the needs of the child. For the mind there are the

Mrs. M. L. Johnson.

Learning to use their hands.

acquaintance with nature at first hand, the solving of problems in the making of things, the controlling of forces and of materials, the mastery of quantity in the measuring and weighing and calculating, the learning of stories from history and from literature, with their instinctive dramatization. There is constant translation of words into thoughts and actions. Finally, the health of the spirit is ministered to by the provision of "sincere experiences" in relation to other children and in relation to the forces and materials of nature and industry. There is joy in the work, because the work has meaning. Mrs. Johnson sees very clearly that half-hearted work is insincere, and that the attempt to develop "will-power" through arbitrary requirements more often cultivates dishonesty.

There are no set requirements for the first six years of the school. Then the children have an opportunity to learn to read; this they now do with avidity because they have learned that the books contain a great deal that they care about, and because their bodily and mental health makes the task very easy indeed. They learn to love books, because books have never been associated in their minds with anything disagreeable or burdensome. They easily learn to write, since they have muscular control and there is interest in the use of writing.

Mrs. Johnson's attitude toward the school as an institution is well expressed in the following:

Institutions to be educational must meet the demands of the individual, rather than make requirements which he must meet. An institution has no right to ask "What do you know?" "What have you done?" "Where are your credentials?" But must ask "What do you need?" "How may we serve you?" The "standards" of an institution are measured by its services, not by its requirements.

The first group of children with whom Mrs. Johnson began her experiment have reached the high school. In spite of their late start in reading, writing, and arithmetic, they were up to the "standards" set for children in the regular schools, and excelled the others in health, in intellectual power, in initiative, enthusiasm and spontaneity.

Prof. John Dewey visited the school during the past winter and was deeply impressed by what Mrs. Johnson has accomplished, particularly in view of the many local difficulties and the absence of special equipment or methods. "There are no new devices, no tricks of the trade, no unique or even peculiar appliances," writes Prof. Dewey. "What has been done is simply to provide the conditions for the wholesome, natural growth in small enough groups for the teacher (as a leader rather than as an instructor) to become acquainted with the weakness and powers of each child, and then to adapt the work to the individual needs."

This summer there was conducted a demonstration class and a normal class in the principles of organic education, at Greenwich, Conn., for the second time. Here teachers had an opportunity to become familiar with what is perhaps the most significant experiment in education yet undertaken in this country.

## Street Sprinkling Trolley Cars*

Two street sprinkling cars have been put into operation on the tracks of the street railway of Hanover, Germany. The cars are provided and maintained by the fire department, which also furnishes the sprinkling operators and pays the railway company for the use of its tracks and power, and the services of the motormen.

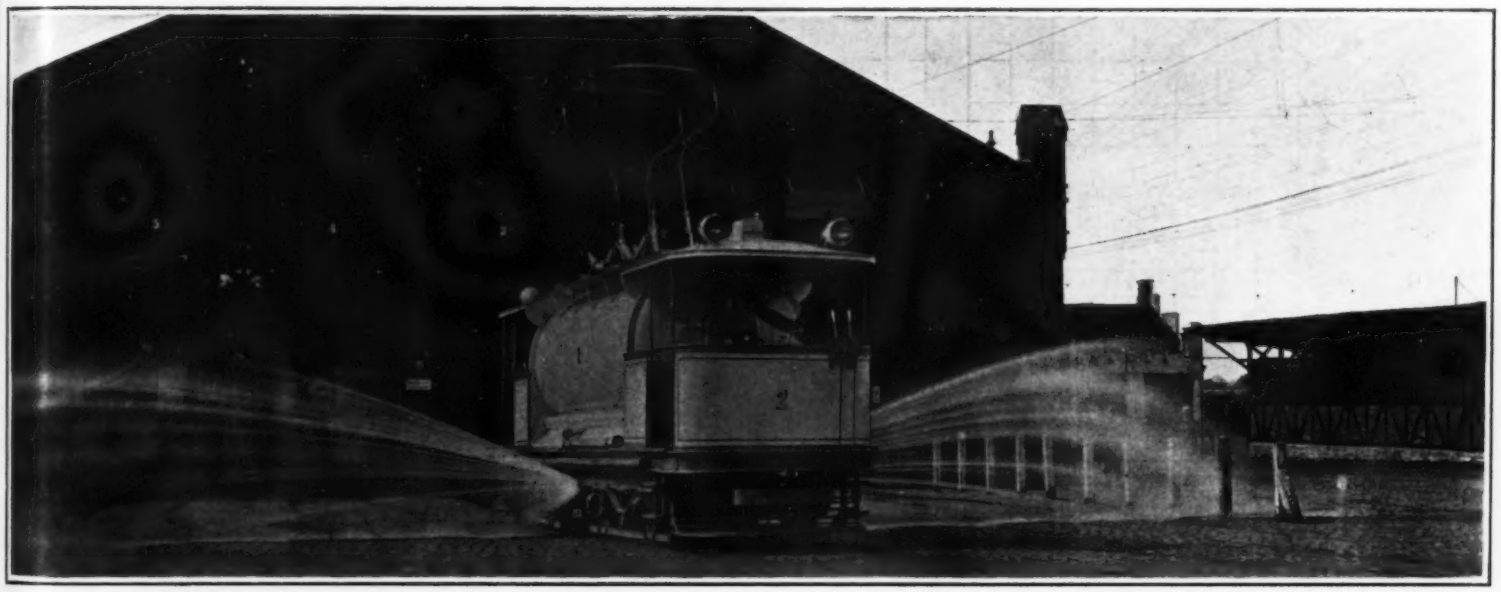
The car first constructed proved so superior to the horse-drawn sprinkling wagons that a second car, of somewhat different construction, was soon added.

Each car has four axles and carries a cylindrical water tank of 3,170 gallons capacity. In the first car the water is expelled by maintaining, by means of a motor-compressor, an air pressure of one atmosphere above normal above the water in the tank. In the second car the stream is driven by a centrifugal pump. The latter method is simpler and cheaper than the former and it does not require the tank to be air-tight throughout. A 5 horse-power motor, which is used only during the actual sprinkling, suffices for the operation of the centrifugal pump, while a 7 horse-power motor is required for the air compressor.

Each car carries three sprinklers, one for the space between the rails and two for the roadway outside of the rails, and each sprinkler can be opened, closed and regulated, independently of the others. The maximum width that can be sprinkled is 85 feet. In the first car the sprinklers are opened and closed, and the width of the spray is regulated by a complicated system of levers, but in the second car all of these operations are performed by compressed air more promptly and accurately and with less fatigue of the attendant. Both cars have air brakes supplied by motor-compressors.

The average daily work of each car, working sixteen hours, includes 56 miles of roadway sprinkled, 12½ miles of travel light and 20 fillings. With an average width of spray of 36 feet, nearly 11,000,000 square feet are sprinkled in an average day.

* From *Elektrische Kraftbetriebe und Bahnen.*



Street sprinkling trolley car. The spray jets are easily regulated.

Street sprinkling trolley cars in Hanover, Germany.

# Design of Floats for Hydro-Aeroplanes—I*

## Giving the Results of Tank Experiments with Various Models

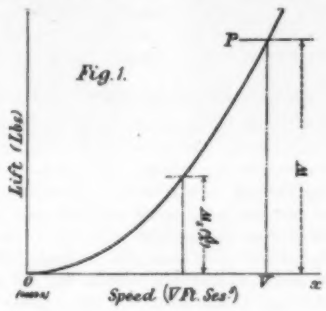
By G. H. Millar, B.A.

THIS paper is founded on a series of experiments made by Mr. G. S. Baker and the author at the William Froude National Tank, at the instance of the Advisory Committee for Aeronautics. The work consisted of designing and running a large number of models of hydro-aeroplane floats, some of which have been subsequently built to. The special apparatus employed and methods of experiments are described in the Appendix, while the complete results are included in the Official Aeronautical Reports for 1912–13 and 1913–14. It should be borne in mind that the statements here made, and conclusions arrived at, are founded mainly on these model experiments, while many details can only be decided as the result of experience with actual machines.

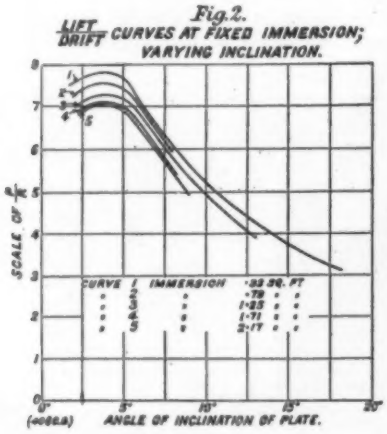
Hydro-aeroplanes may be divided, broadly, into two classes: (1) Those in which the machine follows the same general lines as a land machine, with floats substituted for the landing-gear; (2) those in which the fuselage is in the form of a boat containing the crew, and sometimes the engine. The term "hydro-aeroplane" is usually confined to machines of the first class, those of the second being termed "flying boats." These two classes are being developed side by side; in some cases both are built by the same manufacturers. The second class is specially popular in America. It is as yet too early to say which will ultimately prove the more useful, but possibly both types will persist, each for its own purpose. This paper is mainly concerned with the first class, the hydro-aeroplane proper, although most of the conclusions come to are applicable also to the "flying boat." At first sight, the latter may appear to be the more seaworthy device; but with a large open cock-pit it is exposed to great risk of swamping. The Curtiss flying boats are fitted with water-tight bulkheads, and have a very large total buoyancy (usually four and a half times the weight of the machine), but this necessitates a large boat, which even then cannot altogether take the place of the fuselage of the land machine, especially if the engine is carried overhead.

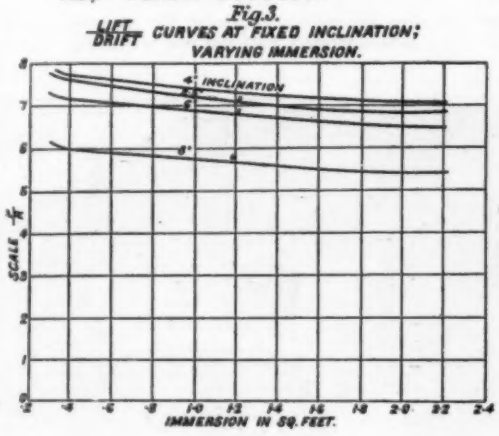
Turning now to the hydro-aeroplane proper, the machine may be supported either (*a*) by a single broad main float, with small subsidiary wing floats, or (*b*) by a pair of floats side by side at a suitable distance apart. In either case a small tail float is usually fitted, which may rest on the water at the lowest speeds, or may be clear of it even when the machine is at rest, and only relied on to prevent the tail of the machine dipping if it is thrown backward by a sudden gust of wind. It is, however, usually preferred to have the center of gravity of the whole machine aft of the center of buoyancy of the floats, which, of course, requires that the tail float shall take some of the load at rest. This also makes the machine float more steadily in a short sea, and allows an underwater rudder to be used to assist maneuvering on the water at low speeds. In any case the load on the tail float is small, and its design of no particular moment.

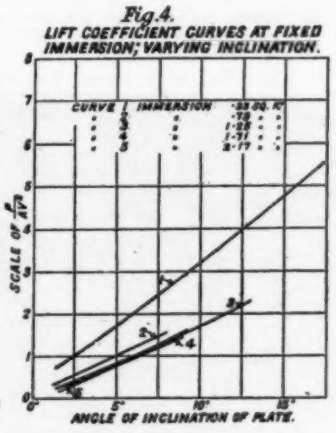
Considering the main floats, the general balance of

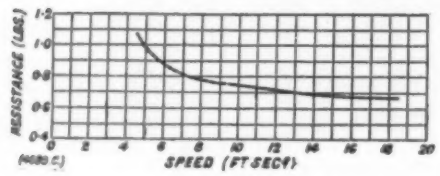


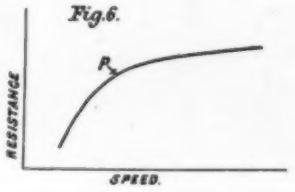

FLAT PLATE RESULTS.

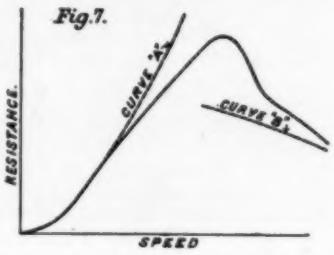



opinion seems to be decidedly in favor of twin floats. With a single float the lateral stability (on the water) is small, unless the float is unduly broad for its length, and wing floats become essential. On the other hand a pair of floats placed too far apart may cause a severe slewing strain if one becomes more deeply immersed than the other. As regards efficiency, experimental results show that if a pair of floats be replaced by a single one of similar design but double the breadth, much the same results will be obtained, although the water disturbance is more noticeable. The performance of twin floats is not appreciably affected by their distance apart, provided that the gap is not less than the breadth of either float. It is generally agreed that the total buoyancy of the floats should be at least twice the dead-weight of the machine, and water-tight bulkheads are frequently fitted. These incidentally prevent any water that may leak in from flowing from end to end of the float when in the air. The air resistance of the floats must be taken into consideration, and their construction is a matter of some difficulty, great strength being required with a light weight.

The design of hydro-aeroplane floats is naturally very closely allied to that of hydroplane boats, though with some important differences. Since the lift of the aerofoils increases continuously with the speed, and ultimately becomes equal to the weight of the whole machine, it might be thought that any fine lined ship-shaped form would be suitable for a float, but this is not the case. Fig. 1 shows the curve of lift for an aeroplane of "*W*" pounds total dead-weight designed to leave the water at a speed of *V* foot-seconds, it being assumed that the angle of attack is constant throughout. This curve is simply a parabola described to touch the axis *Ox* at the origin, and to pass through the point *P* (*V*, *W*). The ordinate at any speed *v* (less than *V*) is, of course, $\left(\frac{v}{V}\right)^2 W$.

Now it will be seen that the lift is comparatively small until a high speed has been attained; at half speed it will be only one-quarter of the dead-weight of the machine. But even this speed is a very high one for the length of the float, and consequently for a float not designed on hydroplane principles the resistance and wave-making will become enormous before the air lift becomes appreciably great, and the machine will never reach its flying speed, unless with a strong head wind.

It may here be well to consider the principles on which hydroplane design is based. Any normal form of vessel will rise and skim along the surface of the water if she is towed fast enough. But in the case of a ship designed for low speeds, the speed at which she begins to rise is a very high one, and up to this point wave-making and resistance will increase to a prohibitive extent.[1]

Now, a hydroplane is so designed that when a high speed is attained the normal pressure of the water on the hull shall have a large vertical component, which raises the boat and so decreases her displacement, and, consequently, the wave-making. The simplest way of attaining this result is to provide the boat with a flat bottom, which, at high speeds, shall have an inclination of about 5 degrees to the horizontal, in a fore-and-aft direction.

Figs. 2, 3 and 4, on this page, show the results of some experiments made on flat plates at the William Froude Tank. The plates were 1 foot wide, and were towed on the surface of the water at a series of small angles, and at speeds of 600 feet, 800 feet, 1,000 feet, and 1,200 feet per minute. The immersion was also varied independently, and the vertical force *P* and horizontal force *R* on the plate were measured. In the figures, *V* is the speed in feet per second, and *A* the area of plate immersed in square feet. The plate being 1 foot wide, the number denoting this area also denotes the length of plate immersed and the ratio $\frac{\text{length immersed}}{\text{breadth}}$, which is the inverse of the aspect ratio. These results cannot be taken to be very exact, as there was a considerable variation of $\frac{P}{AV^2}$ and $\frac{R}{AV^2}$ with speed, although an uncertain one. This may have been due to two causes—to the variation with speed of the actual area immersed for a given value of *A* (which was the area immersed when the

* Paper read at the joint meeting of the Institution of Naval Architects, the Institution of Engineers and Shipbuilders in Scotland, and the North-East Coast Institution of Engineers and Shipbuilders, at Newcastle-on-Tyne. Reproduced from *Engineering*.

[1] In the case of a mercantile form model run at the William Froude Tank, for a ship 400 feet long, the E. H. P. required at 14.8 knots was 4,115, and at 16.5 knots was 10,900, the resistance increasing as the sixteenth power of the speed between these points.

plate was at rest at the same angle and height); or to errors in estimating the position of the center of pressure, which could not be directly measured with the apparatus then in use.

Fig. 3 shows that the efficiency of such a plate increases with increase of aspect ratio, but that the effect is not a very marked one, over the range here considered. At large aspect ratios the efficiency seems to increase considerably, and, with single-plane floats at high speeds and small loads, efficiencies of as much as 10.5[1] have been obtained, although this was perhaps a little too high. With a plate of an aerofoil section and an aspect ratio 6 : 1, having its chord at 4½ degrees, and its leading edge just above the water surface, an efficiency of 11.8[1] was obtained.

Fig. 5, above, is deduced from Figs. 2, 3 and 4, by calculation, and shows the resistance of a plate 6 inches wide at a constant angle of 6 degrees and a constant load of 4.86 pounds at speeds of 10 feet to 18 feet per second. It will be seen that the resistance actually falls as the speed increases over this range. The curve cannot be extended down toward zero speed from the experimental results, but it will be obvious that at a very small speed a very great length of the plate must be immersed to support any load; hence the curve, if produced toward zero speed, must be of the nature shown by the dotted line—i. e., asymptotic to the axis of resistance.

Fig. 6 shows the general appearance of the curve of resistance to a base of speed for a hydroplane (having a constant load). It will be seen that at the point $P$ the rate of increase of resistance rapidly falls off. This is the point at which the boat commences to rise in the water, and after this the resistance only increases very slowly. In the case of a hydro-aeroplane float running at a constant angle the load is constantly decreasing; the load at a speed $v$ is $W\left(1-\frac{v^2}{V^2}\right)$, where $V$ is the speed at which the machine begins to fly and $W$ the dead-load. Hence, the curve of resistance to a speed base takes the form shown in Fig. 7, having a "hump" (which may be sharp and peaky or flat and spread out) at the point where the float begins to rise in the water, and afterwards falling off rapidly till at the flying speed it denotes the air resistance of the float. In the same figure, curve "$A$" denotes the resistance the float would have if constantly kept at the same vertical height and prevented from rising; curve "$B$" denotes the resistance of a flat plate carrying the same load as the float. The curve for the actual float tends to follow curve $A$ at moderate speeds and curve $B$ at planing speeds, the hump representing the intermediate stage when the float is rising sharply in the water.

The problem of designing a hydroplane that shall have a small resistance at a planing speed is a comparatively simple one. But the requirements for such speeds differ considerably from those for low resistance at moderate speeds. As a matter of fact, at speeds up to the "hump" speed any hydroplane is a very bad boat. Consider first the requirements at planing speed. Fig. 8, above, shows the wave system generated by a flat plate towed along the surface at a high speed and small angle (6 degrees), the fore end of the plate overhanging. It will be observed that the plate scoops out a hollow in the water, which does not fill up until some way astern of it. The water which passes underneath the plate issues at the back in a smooth stream, which at first follows the direction of the plate, but gradually turns upward again. From the crests of the bow diverging waves the surface slopes down to this smooth region, meeting it in a well-defined line. At the points $K$, $K$ two converging waves appear to leave the inner walls of the diverging waves, and these meet to form a curious "fan" of partly broken water. At the after end of the "fan" another diverging system starts with a smaller one inside it. This system is really a continuation of the converging waves which cross at the "fan."

[1] This is the value of the ratio $\frac{P}{R}$.

*Fig. 8.*

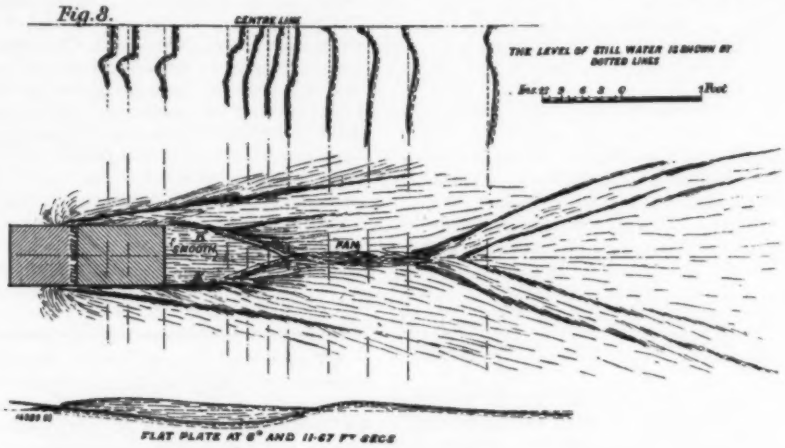



*Fig. 9*

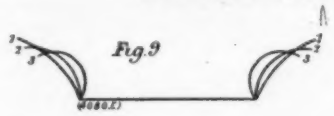


*Fig. 11.*

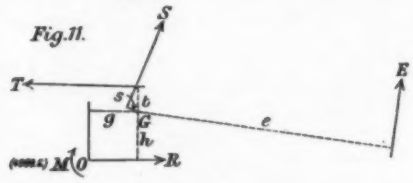



*Fig. 10*

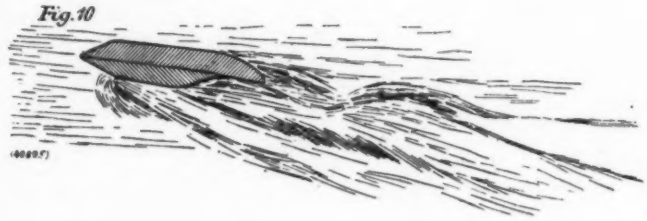
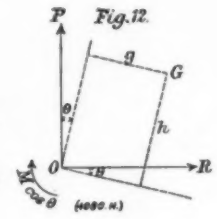


*Fig. 12.*




Type 1 wave will go clear of the sides, type 2 will just do so, but type 3 will force a thin film of water up the side of the float, which will add very considerably to the resistance. Again, where the wave is of type 1, the sides may be flared considerably, without touching the wave, and where the wave is of type 3 they must "tumble home" from the bottom to clear it. With a vertical-sided and flat-bottomed float thin filmy waves will always rise against the side of the float at a moderate speed, which will gradually move aft as the speed increases till they leave it altogether. The sketch in Fig. 10, below, shows their appearance when the speed is reached at which they start to leave the float. These clinging waves may, however, be thrown clear of the sides by the use of bilge-planes (better known, perhaps, by the facetious title of "mud-guards").

The waves set up by our elementary plate will not be affected if we build up a boat form upon it, provided that the total load is the same, and that no part of the boat except that formed by the plate touches or comes very near to the surface of the water. In particular, it may be observed that by forming a step at the back edge of the plate we may build on a tail to the boat aft of this point, which will be completely clear of the water at a certain speed. To make the sides of the boat clear of the waves at the lowest possible speed, they should have increasing tumble-home toward the after end, while they may be flared a little at the forward end. The use of tumble-home on the after part of the sides is, however, not without its objections in the case of a hydro-aeroplane float, as it tends to throw the water up when turning. We have so far considered a boat or float having only a single "planing" surface. We may, however, have any number of such surfaces separated by steps. Each plane will then set up its own system of waves, and the diverging crests from one plane may even cross the crests from the plane ahead of it.

*Fig. 13. TYPE 1. (MODEL 98)*
PARALLEL VERTICAL SIDES
ALL SECTIONS RECTANGULAR.

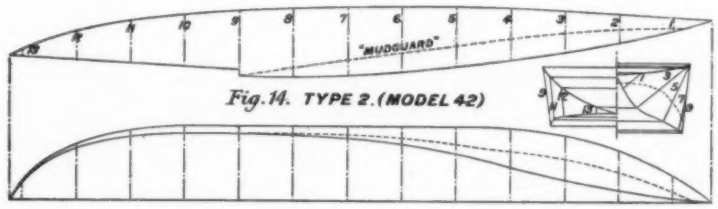



*Fig. 14. TYPE 2. (MODEL 42)*

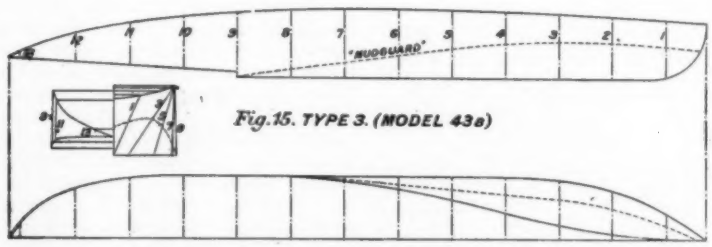



*Fig. 15. TYPE 3. (MODEL 43a)*

It is not difficult to design a float which shall have a good efficiency at "planing" speeds. But this is not nearly so important as the behavior of the float at lower speeds. From a resistance point of view, the important range of speed is that up to the "hump" on the resistance curve, during which it must be considered as a displacement boat.

The essentials for good "planing" are:

1. Considerable overhang at the forward end with short immersed length and suitably-shaped bottom.

2. That the water should leave the bottom of the boat on a sharp edge both at the stern and at the sides.

For a fast displacement boat we require:

1. A fine curve of sectional areas, and consequently great length with small beam, or light draught.

The whole system is merely an extreme case of that of an ordinary high-speed ship, where the "fan" occurs as a region of high-pressure under the after end of the ship. The diverging system aft of the fan corresponds to the ordinary stern diverging system. In a high-speed destroyer, the "fan" may sometimes be seen clear of the stern. If it is just underneath the stern, the space bounded by the diverging waves aft of it will appear as a plateau of broken water.

Fig. 9 shows a transverse section of the plate and the bow diverging wave. The latter will change from type 1 to type 2, and from type 2 to type 3, if the speed be decreased, or the depth of immersion of the element is increased, and the same gradual change occurs as we go aft along the plate. That is to say, the inner wall of the wave becomes steeper and more convex up to the point where the crest has its maximum height. Now, suppose the plate to form the bottom of a float with vertical sides.

2. No sharp corners or edges in contact with the water; they produce eddy-making, and consequent waste of power.

3. Smallest possible wetted surface to reduce surface friction. This is not so important as condition 1, except at very low speeds.

We have, therefore, to try and satisfy two sets of conditions which are in some respects antagonistic.

First, as regards length. At speeds below the "hump," increase of length and decrease of breadth produce considerable improvement. At "planing" speeds they are slightly detrimental, and will probably cause the "hump" to come at a slightly higher speed, but in the case of a stepped float this may be partially counteracted by the fact that the narrower float will require less air at the steps. On the whole, a float can always be improved by increasing the ratio of length to breadth up to an excessive limit. From a practical standpoint, very long floats are highly undesirable; a good float can be got out on a length to breadth ratio of about 5½ to 1, and in the author's opinion a ratio of about 6 to 1 should not be exceeded, although a good many floats have a ratio of 7 to 1 or more.

It has been seen that for a flat plate the most efficient angle is 4 degrees, and for a float having a flat planing surface the best results would be obtained with the surface at the same angle. In practice, however, it is better to design the floats to run at a slightly greater angle, so as to give a greater margin of safety when alighting. In the series run at the William Froude Tank, the normal running angle was taken to be 6 degrees for the forward or main planing surface, or in the case of a cambered surface the mean angle was 6 degrees. The model floats were made to a scale of $\frac{1}{3.5}\frac{1}{7}$ for a machine of 2,200 pounds weight designed to leave the water at a speed of 67 foot-seconds in a calm. For convenience, these figures will be taken as the standard for the rest of the paper.

It might be thought that the pilot would be able to run the machine on the water at any angle he desired, just as he can in the air; as a matter of fact, the water forces on the float may introduce very large trimming moments, quite outside the pilot's range of control. The magnitudes of the moments brought into play are therefore a very important part of the design. Suppose that for a given float, or pair of floats, running at a given angle and speed, the reaction of the water on the floats is represented by vertical and horizontal components $P$, $R$ pounds, and a moment of $M$ foot-pounds, about some point $O$; these quantities can be determined from model experiments. Let $G$ be the center of gravity of the whole machine (including the floats), and let the horizontal and vertical co-ordinates of $G$ relative to $O$ be $(g\ h)$ feet. Let $T$ be the thrust of the propeller, and $t$ the distance of its line of action from $G$.

Also let the force on the elevator and tail-plane be $E$ pounds acting in a line distant $e$ from $G$, and let $S$ be the resultant resistance of the machine (apart from the floats) acting in a line distant $s$ from $G$.

Then for angular equilibrium we have, with the convention of signs shown in Fig. 11:

$$Ee + Tt - Ss = M + Pg - Rh,$$

the trimming moment being reckoned positive when it tends to depress the tail of the machine. The expression $Tt - Ss$ is usually very small; for a machine of the weight considered, at a speed of from 30 to 40 foot-seconds, it will probably not exceed 150 foot-pounds at the most; and a calculation of the elevator control ($Ee$) for a specific machine of this weight gave the following maximum values:

| | | | | | | |
|---|---|---|---|---|---|---|
| Speed, ft. secs. | 10 | 20 | 30 | 40 | 50 | 60 |
| Control, ft.-lb. | 68 | 272 | 632 | 1088 | 1700 | 2528 |

We can therefore calculate the limits within which the moment $M_o \equiv M + P\,g - R\,h$ must be kept if the machine is to be run at its designed angle, although these limits may be exceeded momentarily.

The value of $M_o$ at any speed and angle is, of course, very largely dependent upon the position of the floats relative to $G$—that is, on the value of $g.\ h$. For the machine considered $G$ is at a height of about 6.3 ft. above the bottom of the floats, so that the part of $M - R\,h$ due to resistance is of some importance. Now the height of $G$, and, therefore, the value of $h$, will be decided on in the early stages of the design. We therefore require a simple means of determining the most suitable value of $g$. One method of doing so is as follows:—The values of $M$, $P$, $R$, referred to a definite point $O$, are determined from model experiments for a range of speeds and angles and the value of $h$ is decided on. Consider, first, the case in which the angle is constant (say 6 deg.) and the speed varies. Then $M_o = M - R\,h - (-P\,g)$.

On a base of speed plot the values of $-P\,g$ ft.-lb. for $g = 1$, *i. e.*, of $-P$ ft.-lb. (Figs. 21, 24, and 26, next issue) The result is an inverted parabola, which, by distorting the abscissa scale, can be reduced to a straight line. $P\,g$ will now for every value of $g$ be represented by a straight line, all such straight lines radiating from a point in the base line. At the distorted abscissa points erect ordinates denoting the values of $M - R\,h$ and join up the ends of these ordinates to form an open polygon. Then, taking any desired value of $g$, the value of $M_o$ is given by the distance from the corresponding $P\,g$ line to the polygon curve, being positive if measured upwards, and negative if measured downwards. We can thus see by inspection the effect on the moments of altering the value of $g$.

We also require cross-curves showing the value of the moments at constant speed and varying angle, which will show us what change of trim (if any) is likely to take place at any speed. Similar diagrams can be prepared for this case. In the model apparatus used at the William Froude Tank the value of $M$ as read is only strictly correct at 6 deg. inclination of float. At any other angle (6 deg. + $\theta$ deg.) the true moment is $M\cos\theta$, while, whatever the angle, $P$ and $R$ are always measured vertically and horizontally.

Hence (see Fig. 12) the moment is now—

$$M_o \equiv M\cos\theta + P\,(g\cos\theta + h\sin\theta) - R\,(h\cos\theta - g\sin\theta),$$

which may be written:—

$$M\cos\theta + h\,(P\sin\theta - R\cos\theta) - [-g\,(P\cos\theta + R\sin\theta)].$$

We now plot $-g\,(P\cos\theta + R\sin\theta)$ ft.-lb. to a base of angle for $g = 1$, and distort the abscissa scale to make it a straight line; then plot $M\cos\theta + h\,(P\sin\theta - R\cos\theta)$ at the new abscissa points, and proceed as before (see Figs. 22 and 23). In this case, $\theta$ being small, a rough approximation may be obtained by plotting $-P$ instead of $-(P\cos\theta + R\sin\theta)$ and $M - R\,h$ instead of $M\cos\theta + h\,(P\sin\theta - R\cos\theta)$, and spacing the ordinates at any convenient distance apart. If the variations of $P$ with angle be also neglected,[1] we get a straight line parallel to the base.

We require some point of reference for the horizontal position of the *C.G.*, and the most convenient one is the position of the center of buoyancy of the float when fully loaded and inclined at the standard angle of 6 deg. The value of $g$ to bring this point vertically under the *C.G.* is then calculated, and the corresponding line drawn on the moment diagram. We can then readily see the effect of placing $G$ at any desired distance aft of the *C.B.*

It is now proposed to consider some float design in detail. Fig. 13, above, shows a type of float that has been more widely employed than any other. It is simple to construct, and has given good service in practice. It has a rectangular water-line at all speeds, and therefore should have fine bow-lines; but, as usually made, the curve of areas is not particularly fine forward. This is, however, partially compensated for at moderate speeds by the large amount of lifting surface, which causes the float to start rising in the water at quite low speeds.

Cling waves form against the sides, and do not leave them until rather a high speed is attained. The long overhang required forward makes the float very stable at small angles, but otherwise is so much wasted length. Such a float naturally tends to "slam" badly in a short lop. Floats of this type are sometimes fined at the forward end by pinching in the sides.

Figs. 14 and 15 show two floats of a very different type that were included in the series of floats evolved at the William Froude Tank. Of these, type 3 (Fig. 15) is the better, its flat under surface being all at the most efficient angle. Both these have tail appendages, which leave the water completely before the hump speed is reached if the floats are maintained at an angle of 5 deg. to 6 deg.

*(To be concluded)*

[1] The effect of neglecting this is to decrease the moment numerically at angles below 6 degrees, and to increase it numerically at angles above 6 degrees.

## Corrosion of Condenser Tubes

In many places the destruction of condenser tubes through pitting or corrosion results in considerable expense. An article by Mr. E. Bate in the *General Electric Review* deals at some length with causes leading to the pitting and corrosion of condenser tubes. These causes may be briefly stated thus: Stray currents from earthed systems, galvanic currents between the dissimilar metals of which the condenser is constructed, galvanic currents due to deposits of active material inside the tubes, use of unsuitable mixture for the material of the tubes. The increasing use of negative boosters on earthed systems prevents the first-mentioned point from being of serious importance. Regarding the second point, the alloy of which the tubes are usually composed is electro-negative to the cast iron casing, so that no corrosion of the tubes could be caused by these currents. That the third cause is responsible for the greater majority of tube failures is borne out by the fact that 96 per cent of the tubes examined by the author were pitted in the lower half, where, of course, all internal deposits would collect. It is suggested that in cases where the circulating water is drawn through a long line of cast iron piping, oxide of iron and carbon may be deposited in the condenser tubes, thus giving rise to injurious electrolytic action. The author is of opinion that, once local corrosion has commenced, it cannot practically be stopped. A suggested method of preventing this deleterious deposit in the condenser tubes is to treat the interior of the cast iron piping so as to prevent corrosion, and to keep the intake pipes as short as possible.

## Fog Signals by Wireless

In the Firth of Clyde, in Scotland, several fog signal stations have been established which are operated entirely by wireless currents sent from a distant station, and require no attention other than the periodic replenishment of the necessary supplies. The signal is in the form of a gas gun in which a charge of acetylene gas air is fired at regulated intervals so that it identifies itself. The gas admission and ignition is quite automatic, and once the gas is turned on the cycle of operations proceeds regularly. All that is required is to control the gas valve electrically, so that it can be turned on in time of fog. The needle valve used for the purpose is actuated by two electromagnets, one for opening and the other for closing. These are controlled by a relay working in conjunction with a special form of coherer, which receives the signals through a jigger transformer. The principal feature of the apparatus is the selective synchronizer, by which the apparatus only responds to a particular signal, different signals being employed for the turning on and turning off circuits. A 14-foot receiving aerial of the wires is used, and the transmitting apparatus is of the simplest character, embodying synchronizers of similar nature to the receiving synchronizers for giving the correct signals.

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625 F Street, N. W.,
Washington, D. C.

SCIENTIFIC AMERICAN SUPPLEMENT
Founded 1876
NEW YORK, SATURDAY, NOVEMBER, 14, 1914
Published weekly by Munn & Company, Incorporated
Charles Allen Munn, President; Frederick Converse Beach, Secretary; Orson D. Munn, Treasurer
all at 361 Broadway, New York
Entered at Post Office of New York, N. Y., as Second Class Matter
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## Table of Contents

| | PAGE |
|---|---|
| How to Collect and Preserve Insects.—II.—By Frank E. Lutz.—Illustrated | 306 |
| A Course of Science Reading.—By James Asher | 307 |
| The Hoang Ho Bridge.—Illustrated | 308 |
| Leadless Glazes on White Wear | 308 |
| Direct Determination of Rubber by Combustion Method | 308 |
| Difference of Longitude Determined Photographically | 308 |
| A New Apparatus for the Direct Measurement of Radiography.—Illustrated | 309 |
| Radium Therapy | 310 |
| Protecting Canal Bottoms Against the Erosions Caused by the Use of Screw-Propelled Vessels.—By Our Berlin Correspondent | 311 |
| The Propulsion of Submarines | 314 |
| The Protective Treatment Against Typhoid Fever | 314 |
| A Direct Reading Psychrometer.—By F. W. L. Peebles.—Illustration | 315 |
| A Device for Regulating Storage Batteries from a Distance.—Illustration | 315 |
| An Experiment in Organic Education.—By Sidonie Matzner Gruenberg.—Illustrated | 316 |
| Street Sprinkling Trolley Cars.—Illustrated | 317 |
| Design of Floats for Hydro-Aeroplanes.—I.—By G. H. Millar, B.A.—Illustrated | 318 |
| Corrosion of Condenser Tubes | 320 |
| Fog Signals by Wireless | 320 |